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OOD PLAIN MANAGEMENT STUDY

**MISTEGUAY CREEK
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN**

OCTOBER 1989



prepared by:

**U.S. Department of Agriculture
Soil Conservation Service
East Lansing, Michigan**

in cooperation with:

**Michigan Department of Natural
Resources
Saginaw County Board of
Commissioners
Misteguay Creek Intercounty
Drainage Board
Albee and Maple Grove Townships
Saginaw Soil Conservation District**

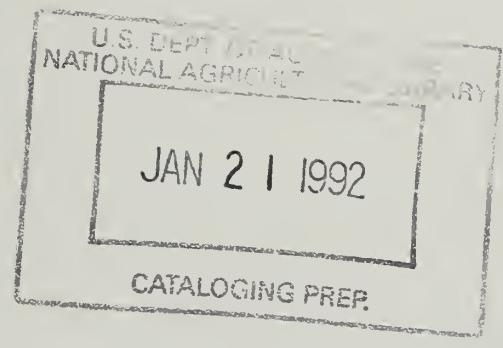
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FOREWORD

This report defines the flood characteristics of Misteguay Creek located in Genesee, Saginaw and Shiawassee Counties, Michigan. Development exists within the flood plain and can be expected to increase in the future. The Flood Plain Management Study assumes the existing dams do not fail.

Flood Evacuation Standard Operating Procedures, to be implemented in the event of large storms that could lead to dam failure, have been prepared under separate cover for Saginaw and Shiawassee Counties. Information for Saginaw County may be obtained from Saginaw County Emergency Services, 111, S. Michigan, Saginaw, Michigan 48602 (Telephone 517-790-5434) and information for Shiawassee County and the Village of New Lothrop may be obtained from Shiawassee County Emergency Services Director, 701 S. Norton, Corunna, Michigan 48817 (Telephone 517-743-2229). Breach inundation maps and official actions are included in the Flood Evacuation Standard Operating Procedures.

This cooperative report was prepared for the guidance of local officials in planning the use and regulation of the flood plain. Four potential floods are used to represent the degrees of major flooding that may occur in the future. These floods; the 10-year, 50-year, 100-year and 500-year; are defined in the report and should be given appropriate consideration in future planning for safety of development in the flood plain. Over 28 miles of high water profiles along Misteguay Creek show the expected flood elevations and water depths relative to the stream bed and flood plain. The 100-year and 500-year potential floods are defined by flood hazard area photomaps that show the approximate areas that would be flooded.

Flood hazard area photomaps and high water profiles are based on existing conditions of the watershed, dams, stream and valley when the report was prepared.

Information in this report does not imply any federal authority to zone or regulate the use of flood plains; this is a state and local responsibility. This report provides a suitable basis for adoption of land use controls to guide flood plain development, thereby preventing intensification of flood losses.

Technical documentation for this study is on file with the Soil Conservation Service-USDA, 1405 South Harrison Road, Room 101, East Lansing, Michigan 48823-5202 (telephone (517) 337-6612) and the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909.

Assistance and cooperation of Saginaw County, Saginaw Soil Conservation District, Misteguay Creek Inter-County Drainage Board, Albee Township, Maple Grove Township, Michigan Department of Natural Resources and Michigan Department of Agriculture in the preparation of this report are greatly appreciated.

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FLOOD PLAIN MANAGEMENT STUDY
MISTEGUAY CREEK
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES, MICHIGAN

INTRODUCTION

The flood plains of rivers, lakes and streams have been formed by nature to provide for the conveyance of flood flows resulting from large amounts of snowmelt and rainfall. A PL-566 Watershed Protection and Flood Prevention Project for Misteguay Creek was completed in the 1960's. The installation of flood prevention measures, including three floodwater retarding structures, has had a very significant effect in the reduction of annual floodwater damages in the flood plain areas. However, large runoff events will still inundate a considerable area. Therefore, the long-term solution to reducing flood damage and loss of life is to limit development in the flood plain which could be damaged or which could obstruct the conveyance of flood waters. There are three basic actions which can be used to assure that flood plain areas are kept open or prevent damage:

1. Provide information to make lending institutions and prospective property buyers aware of the flood hazards.
2. Initiate flood plain regulations to prevent the development of the flood plain in a manner which would be hazardous during floods or restrict flood flows.
3. Acquire flood prone areas for use as parks, open space, wildlife habitat and other public uses.

Potential users of the flood plain should base their decisions upon the advantages and disadvantages of such a location. Knowledge of flood hazards is not widespread and, consequently, the managers, potential users and occupants cannot always accurately assess the risks. In order for flood plain management to be effective in the planning, development and use of flood plains, it is necessary to:

1. Develop appropriate technical information and interpretations for use in flood plain management.
2. Provide technical services to managers of flood plain property for community, recreational, industrial and agricultural uses.
3. Improve basic technical knowledge about flood hazards.

Two Michigan state laws provide the Michigan Department of Natural Resources the responsibility and the authority to regulate all development in flood plain areas.

Act 288, Public Acts of 1967, establishes minimum standards for subdividing land and for new development for residential purposes within flood plain areas. This act requires that preliminary plats be submitted to the Land and Water Management Division, Michigan Department of Natural Resources, for review and determination of flood plain limits. Upon completion of review and establishment of the 100-year frequency flood plain limits, the preliminary plat may be approved and minimum building requirements specified.

Act 245, Public Acts of 1929 as amended by Act 167, Public Acts of 1968, requires that a permit be obtained from the Land and Water Management Division, Michigan Department of Natural Resources, before filling or otherwise occupying the flood plain or altering any channel or watercourse in the state. The purpose of this act is to assure that the channels and the portion of the flood plain that are the floodways are not inhabited and are kept free and clear of interference or obstruction which would cause undue restriction of flood carrying capacities.

Requirements established by the Michigan Department of Natural Resources for occupation and development of flood plain areas under Acts 288 and 245 are intended to be minimum requirements only. The Michigan Department of Natural Resources urges local units of government to adopt reasonable regulations which can be used to guide and control land use and development in flood hazard areas.

The Soil Conservation Service, United States Department of Agriculture, carries out flood plain management studies under the authority of Section 6 of Public Law 83-566, in response to Recommendation 9(c), "Regulations of Land Use", of House Document No. 465, 89th Congress, 2nd Session, and in compliance with Executive Order 11988, dated May 24, 1977. Flood plain management studies are carried out in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management". The Soil Conservation Service and the Michigan Department of Natural Resources have agreed to carry out flood plain management studies in Michigan under provisions of the Joint Coordination Agreement dated September 1987. Priorities regarding location and extent of such studies in Michigan have been set in cooperation with the Michigan Department of Natural Resources.

The Saginaw Soil Conservation District, Saginaw County, Misteguay Creek Inter-County Drainage Board, Albee Township, ^{Map}Grove Township and Michigan Department of Natural Resources (Sponsors) believed that a flood plain management study was needed for Misteguay Creek due to urbanization and the flooding problems that have already occurred. The Sponsors have determined that there is an increasing need to properly plan for the preservation and use of the flood plain. They have indicated a need to develop technical information along Misteguay Creek to develop effective management programs.

The Sponsors have adopted resolutions indicating they intend to use the technical information from the flood plain management study as a basis for adopting zoning regulations, health and building codes, subdivision control regulations and such other regulations that may be needed to preserve the environmental quality of their natural resources, and to protect the health, safety, welfare and well-being of the citizens of their communities.

A request for a flood plain management study was made by the Sponsors and a Plan of Work, dated May 1987, was agreed to by the Sponsors, along with the Soil Conservation Service. Financial contributions for this study were made by the Sponsors and the Soil Conservation Service. The Saginaw Soil Conservation District will assist the other Sponsors with public information dissemination.

The Sponsors provided money for aerial photography and topographic mapping for flood plain delineation and for watershed modeling purposes. They also furnished assistance to the Soil Conservation Service in gathering basic data. In addition, they also provided input to identify and select appropriate flood plain management alternatives.

The Land and Water Management Division, Michigan Department of Natural Resources provided coordination services with respect to study area discharges and hydraulics. They reviewed the technical aspects of the study and concurred with study results, as applicable, to implement various state statutes and provisions of the Federal Flood Insurance Program.

Natural flood plain values were obtained by Soil Conservation Service field people. Aerial photographs, soil maps and field checks were used to identify and delineate wetland areas. Topographic maps, planning commission data and communications with government officials were used to determine land use and development trends. Soils information was obtained from the published soil survey reports for Genesee and Shiawassee Counties. A soil survey report for Saginaw County is currently being prepared and soils information for areas in Saginaw County was obtained from the Saginaw County Soil Survey Office.

Historic and archaeological data were obtained from township and county historians. Fishery management information was obtained from Michigan Department of Natural Resources field people.

Two floods are delineated, the 100-year and the 500-year frequency events. These floods have an average occurrence of once in the number of years as indicated; e.g. the 100-year flood occurs once in 100 years on the average. The 100-year flood has a one percent chance of being equaled or exceeded in any given year. In addition to the two floods delineated on the aerial photomaps, the 10-year and 50-year floods are also shown on the high water profiles. The flood plain management program enacted by local action is to be based on the technical results and recommendations of this report.

The Land and Water Management Division, Michigan Department of Natural Resources and the Soil Conservation Service, United States Department of Agriculture will, upon request, provide technical assistance to federal, state and local agencies and organizations in the interpretation and use of the information developed in this study. For assistance contact:

Saginaw Soil Conservation District
265 S. Graham Road
Saginaw, Michigan 48603-9423
Telephone: (517) 781-4070

DESCRIPTION OF STUDY AREA

Watershed Area

The Misteguay Creek Watershed comprises an area of 108,000 acres in Genesee, Saginaw and Shiawassee Counties, Michigan. The study area is part of the Saginaw Bay Area River Basin Study. It is located in the U.S. Geological Survey Hydrologic Unit 04080204. Misteguay Creek outlets into the old Flint River channel at a point approximately 7 miles upstream from the Saginaw city limits. The creek flows generally in a northerly direction. The watershed is about 26 miles long and varies in width from about 3 miles at the outlet end to nearly 10 miles in the headwater area.

Misteguay Creek originates in Genesee County southeast of the village of Lennon. Major tributaries are Rush Bed Creek, Onion Creek, Porter Creek and Northwood Creek. Rush Bed, Onion and Porter Creeks outlet into Misteguay Creek in Shiawassee County. Northwood Creek, which originates in Shiawassee County, flows into Saginaw County and empties into Misteguay Creek at a point about 8 miles above its mouth. Other major tributaries are the Savage and Peart Drains, both of which enter the Misteguay in the lower 2 or 3 miles of the watershed.

A PL-566 Watershed Protection and Flood Prevention Work Plan was approved in 1960. This work plan proposed a 5 year project for the installation of land treatment and structural measures in the watershed. Installation was completed in the late 1960's.

Land treatment measures consisted of cover cropping, diversion construction, waterway development, land smoothing, wildlife area improvement, hedgerow planting, minimum tillage, drainage (closed and open), erosion control structures, tree planting, tree planting (replacement), hydrologic stand improvement, protection from overcutting and damaging logging, and protection from grazing.

The structural measures included 3 floodwater retarding dams, 5.68 miles of dikes and 26.94 miles of channel improvement for agricultural water management purposes.

The drainage area of the Misteguay Creek Watershed to the Flint River is approximately 169 square miles with land uses of commercial, residential, recreation, agriculture, forest and open space. About 15 percent of the area is in woodland and about 75 percent is in cultivated crops. The remaining 10 percent is roads, urban and small water areas and pasture. There are numerous culverts and crossings along the river system. Some of these are restrictive and cause the flooding of roads.

There are 4 soil associations in the drainage area. Fifty-five percent of the area consists of the Capac-Parkhill association. These are very deep, somewhat poorly drained soils on nearly level to gently sloping topography. They have high available water capacity and moderately slow permeability. Twenty percent of the area is the Lenawee-Toledo-Del Rey association. These are very deep, somewhat poorly to very poorly drained loamy and clayey soils on depressional to gently sloping topography. They have moderate or high available water capacity and moderately slow or slow permeability. Sixteen percent of the area is the Tappan-Londo association. These are very deep, somewhat poorly drained or poorly drained loamy soils on depressional to gently sloping topography. They have high available water capacity and moderate or moderately slow permeability. The remaining 9 percent of the area consists of the Tedrow-Granby association. These are very deep, somewhat poorly, to very poorly drained sandy soils that are dominantly nearly level but range to gently sloping. They have low available water capacity and are rapidly permeable.

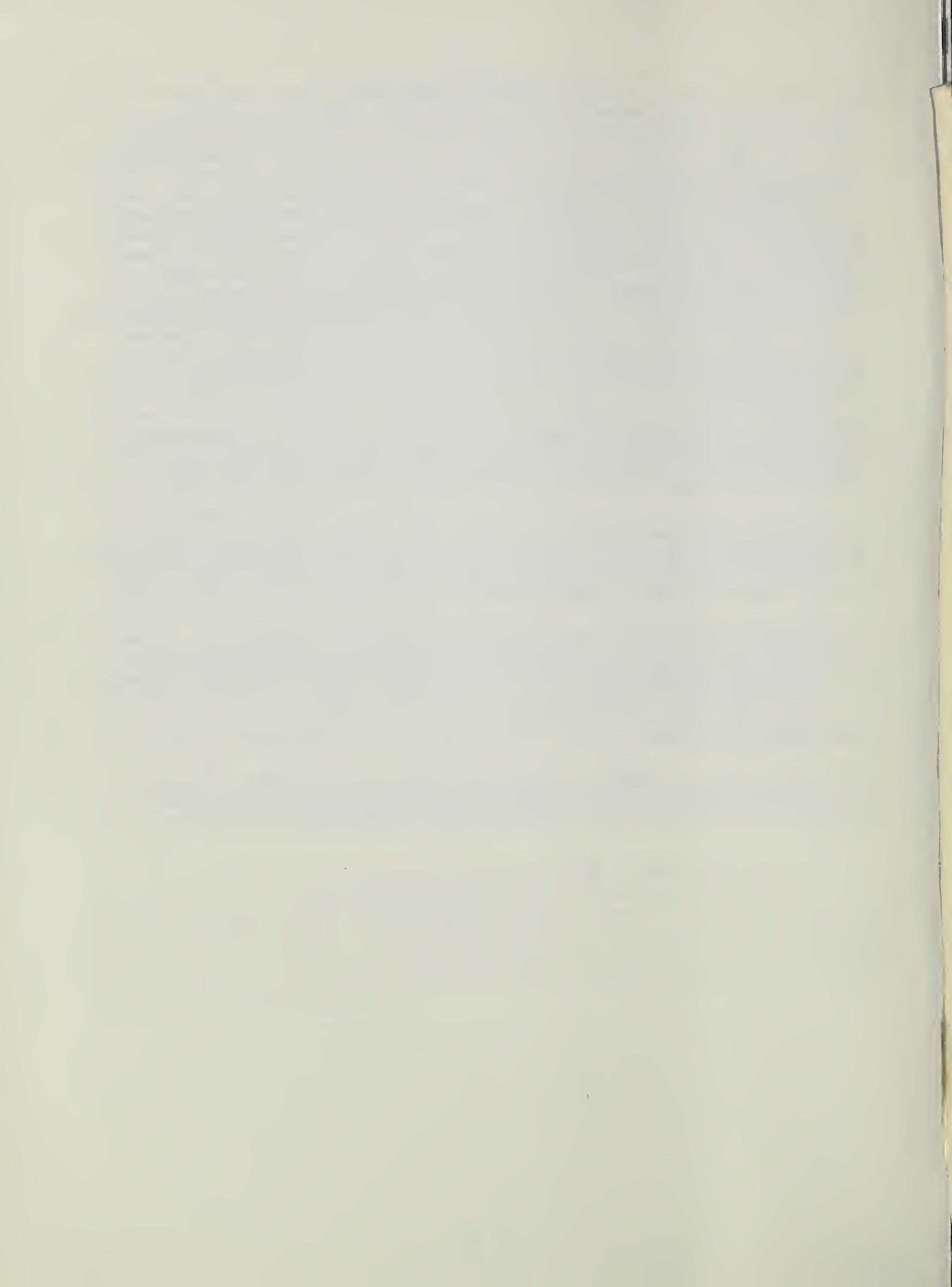
In winter, the average daily maximum temperature is 35°F., and the average daily minimum temperature is 20°F. In summer, the average daily maximum temperature is 68.7°F., and the average daily minimum temperature is 46.6°F.

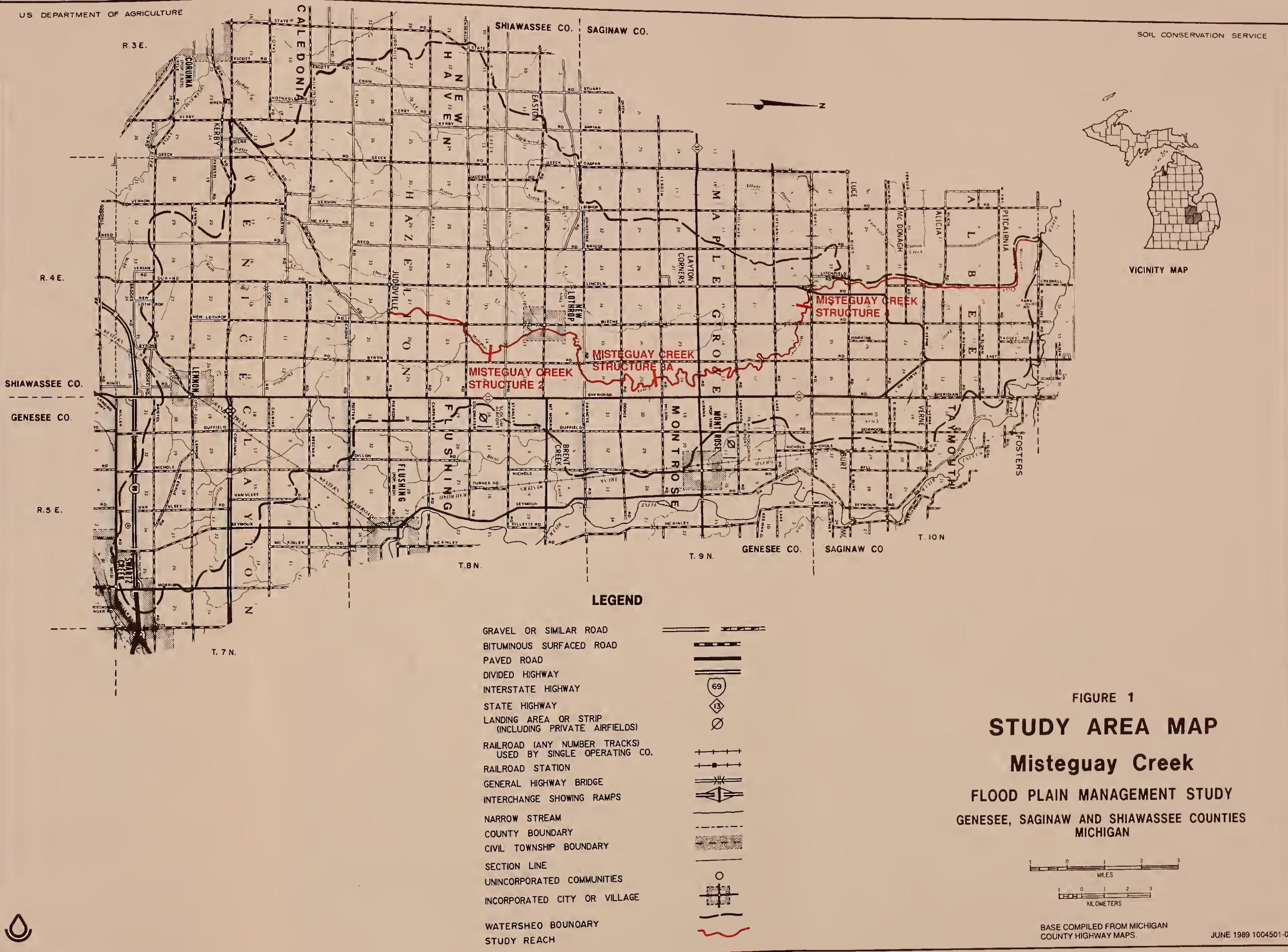
The average annual temperature is 47.8°F. The average annual precipitation is 29.58 inches. Of this, 18.93 inches, or 64 percent, usually falls in April through September, which includes the growing season for most crops. The average annual snowfall is 40.5 inches.

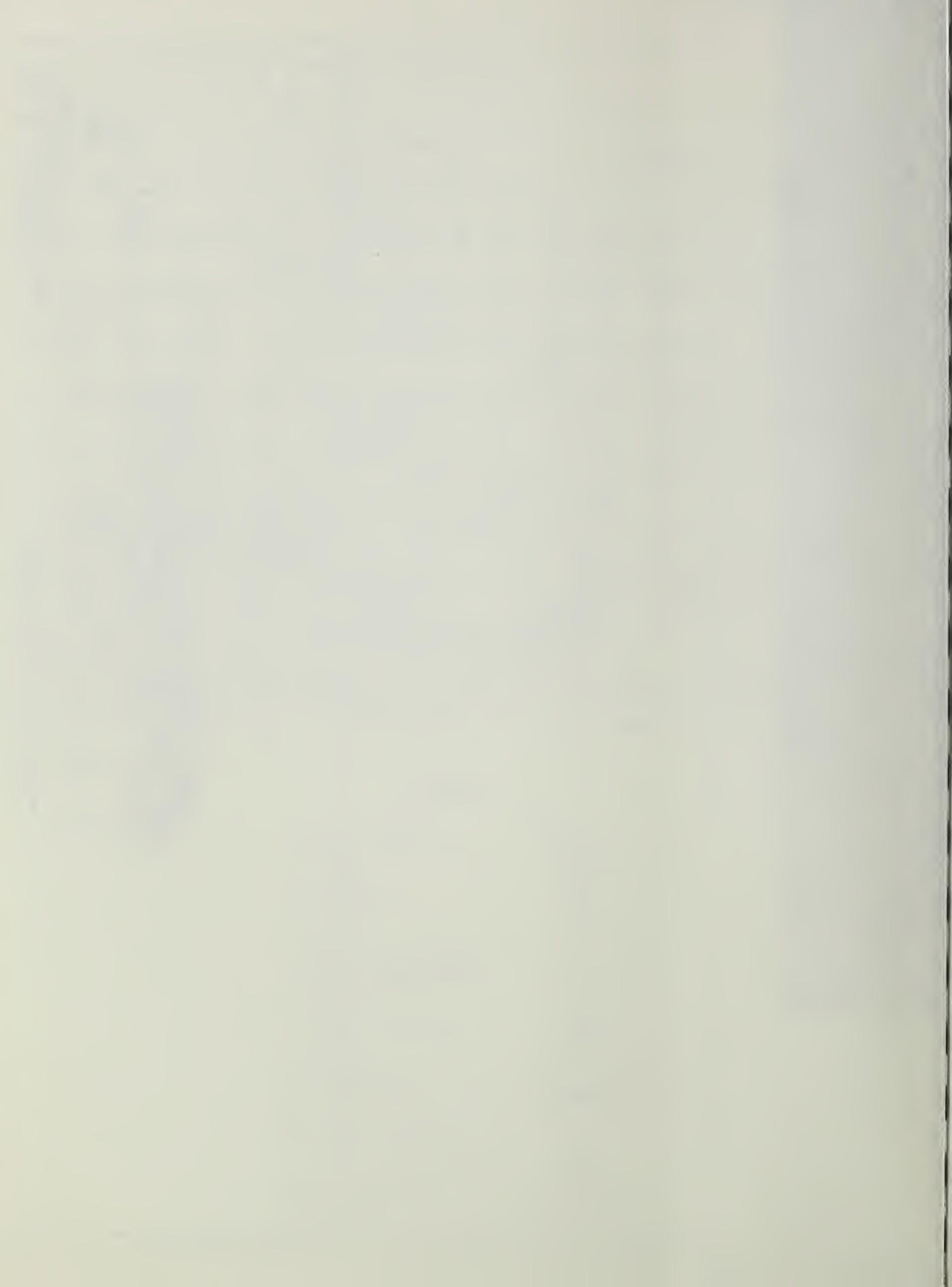
Historically, much of the watershed has been used for agriculture. Since the 1930's, farming has shifted somewhat from livestock to cash crops, mainly corn, soybeans, wheat, dry beans and sugar beets. About 5 percent of the area is used for hay and pasture.

Study Area Flood Plain

The study area is in Genesee, Saginaw and Shiawassee Counties. High water profiles and flood plain delineations were made along Misteguay Creek for a distance of about 28 miles. The study area is identified on Figure 1.







NATURAL VALUES

The Misteguay Flood Plain Area provides a number of benefits. It protects and enhances the environment by storing spring rains and snow melts. It is a filter for minimizing the amount of pollutants reaching streams, rivers and lakes; thereby maintaining water quality. It also supports a wide variety of wildlife and common herbaceous, aquatic and woody plant life.

This flood plain is important for recreation and wildlife. It drains 108,000 acres of watershed. This creek sustains a seasonal fish population mainly in the spring and fall. A large part of the Misteguay Creek in Saginaw County has been dredged; therefore, it lacks the cover, riffles and pools that are necessary for a high quality fishery. It has a large fluctuation in stream flow and temperature due to surface water runoff, which may be turbid and rich in nutrients. Many local residents use Misteguay Creek for fishing, especially in the spring. Important fish species are: carp, redhorse, white sucker, northern pike, and black and white crappies.

Wetlands in the flood plain provide wildlife habitat that includes a wide variety of both herbaceous and woody plants. The location of various plant communities depends largely on the duration of periodic flooding and man's manipulation of water levels.

Hardwood plant communities make up a major portion of the flood plain, interspersed with small emergent shallow marshes. Wooded areas primarily support: silver maple, ash, elm, cottonwood, box elder, hackberry and willow. Trees of less occurrence are: basswood, swamp white oak, sycamore, shagbark hickory and black walnut. Common herbaceous aquatic plants include: cattails, arrowhead, sedges, smartweed, velvetleaf and ragweed. This area also contains substantial stands of wild grapes and poison ivy. The cropland, hardwood, brushland and small marshes provide food and cover for many species of wildlife.

Representative mammals found in the flood plain area are: white-tailed deer, beaver, cotton-tailed rabbit, deer mouse, fox, squirrel, meadow vole, mink, muskrat, red fox and woodchuck.

Common waterfowl that may be found during migration include: Canada geese, mallard duck, green-winged teal and black ducks. Wading and shore birds that use the flood plain include: Great Blue herons, Great (common) egret, Herring gull, Ring-billed gull, Lesser Yellow legs and Killdeer.

Many species of upland birds and non-game birds are also found on the flood plain. As many as 12 bald eagles, which are on the Federal List of Endangered Species, have been seen on or near the Shiawassee Flats. These eagles use the nearby streams, such as the Misteguay Creek, for feeding and resting.

The major uses of the Misteguay Watershed Area are woodland, pasture and cropland. The woodland provides a source of firewood and other lumber products. It is a place for wildlife, recreation and improved visual integrity of the community, and acts to reduce erosion and flooding.

FLOOD PROBLEMS

Annual flooding occurs in the early spring due to a combination of snowmelt and rainfall, and occasionally in the fall due to heavy rains.

The installation of the flood prevention measures in the 1960's has had a very significant effect in the reduction of floodwater damages in the flood plain area of the Misteguay Watershed. Annual damages have been reduced significantly; however, large runoff events still inundate a considerable area.

The 100-year flood would inundate approximately 2,000 acres of land above West Burt Road. Of this, about 800 acres are in the pool areas behind the dams, with most of these areas in wood and idle land. The majority of flood damage is occurring in the lower reaches of the Misteguay Creek below West Burt Road both in and around the Prairie Farm. This damage is primarily due to dike breaching and faulty flap gates. The 100-year flood would inundate approximately 8,700 acres of land of Prairie Farm in addition to about 8,000 acres of adjacent land. Approximately 50 homes and farmsteads would experience flooding during a 100-year flood. Most of the roads crossing the Misteguay Creek would be impassable in the event of a 100-year flood.

TABLE 1 - DEPTH OF FLOW OVER LOW POINT IN ROAD

<u>Road Name</u>	<u>100 Yr. Flood (Depth in Feet)</u>	<u>50 Yr. Flood (Depth in Feet)</u>	<u>10 Yr. Flood (Depth in Feet)</u>
Fry	5.9	4.8	1.9
Verne	3.9	2.9	1.0
Fergus	0.6	-	-
Birch Run	1.0	0.8	-
West Burt	-	-	-
West Gary	-	-	-
Lincoln	-	-	-
Chesaning	2.2	1.8	-
East	-	-	-
Volkmer	2.3	1.8	-
M-57	-	-	-
Ferden	3.4	2.9	0.8
Ditch	-	-	-
Easton	0.2	-	-
Allen	2.2	1.7	-
Henderson	11.6	11.2	9.1
New Lathrop	12.7	12.3	10.2
Riley	2.3	1.9	0.7
Juddville	1.1	0.8	-

West Burt, West Gary, Lincoln, East, M-57 and Ditch Roads would not be inundated by a 100-year flood and could be used by emergency vehicles.

This study provides high water profiles and areas subject to flooding based on analyses of existing stream and dam hydraulics and current watershed and flood plain conditions. This study assumes the 3 dams will not structurally fail. For the purpose of hydraulic analysis, it is assumed the dikes will breach for all major flood events. Water surface profiles along the study reaches are shown for the 10-year, 50-year, 100-year and 500-year flood events. The approximate areas of inundation for 2 floods, the 100-year and 500-year, are shown on the aerial photomaps.

There are areas in the study area that are flood prone and are not shown in this report. These flood prone areas are a result of soil and high water table conditions. The soil surveys for Genesee, Saginaw and Shiawassee Counties describe and delineate these areas.

Typical valley sections shown in Appendix B indicate the effects of the 4 floods. Flood discharges used for computing high water profiles in the study area are shown in Table 3 in Appendix C. Table 4 in Appendix C shows flood elevations at each of the valley sections for present conditions.

Floodways will be delineated for Misteguay Creek and provided to the Sponsors in a separate report.

While no computations were made to reflect the problems of ice and debris blockage at bridges, because of the wide possible variations in conditions, a few generalized comments can be made. Ice and debris can occasionally totally block an opening. To determine possible effects, refer to the high water profile sheets. At each bridge or culvert, a "low point or road overflow" symbol is shown. Based on field surveys, this is the elevation at which the road would flood. If there is no culvert capacity available, all flows would need to go over the road through this low section. The depth of flow and flooding would depend on the quantity of flow, as well as cross-sectional area available for flow.

DETERMINATION OF FLOOD HAZARD FOR SPECIFIC LOCATION

To determine flood levels for a specific location, locate the area of concern on the sheet index, Figure 2 (Appendix A). Select the appropriate flood hazard photomap. Using this photomap, locate the area of concern on the map and its relationship to the nearest identification point (cross-section, road).

If the specific location is outside the flood hazard boundaries, there is no apparent flood hazard from Misteguay Creek flooding, unless the area is subject to high water table conditions (see soil survey reports for Genesee, Saginaw and Shiawassee Counties).

For those areas within the flood hazard boundaries, refer to the adjacent high water profile and locate the area of concern on the profile. The mean sea level flood elevation can then be determined for the appropriate flood event. Table 4 (Appendix C) shows flood elevations at each cross-section.

EXISTING FLOOD PLAIN MANAGEMENT

Currently, with the exception of Albee Township, most of the communities along Misteguay Creek have no existing flood plain ordinances or flood insurance. Albee Township has the Flood Hazard Boundary Map HUD, 8-27-75, Community No. 260498. In addition, the Federal Emergency Management Agency (FEMA) has provided Albee Township a Flood Insurance Rate Map dated 8-1-86. Even though flood plain ordinances are not in effect in most of these communities, the Uniform Building Code (ICBO), enforced in each community, requires that the lowest horizontal structural member be at or above the 100-year flood plain elevation. The flood plain management study will provide the information needed to enforce the existing building code.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

The objectives of flood plain management are to reduce the damaging effects of floods, preserve and enhance natural values and provide for optimal use of land and water resources within the flood plain. Flood plain management can minimize potential flood damages by:

1. Prohibiting uses which are dangerous to public health or safety in times of flood.
2. Restricting building or other development which may cause increased flood heights or velocities.
3. Requiring that public or private facilities that are vulnerable to floods be protected against flood damage at the time of construction.
4. Protecting individuals from investments in flood hazard areas which are unsuited for their intended purposes.
5. Providing information on flood proofing techniques for existing structures in the flood plain.

There are numerous flood plain management alternative categories and tools that can be employed to accomplish the above objectives and goals. The ones that apply to this area are suggested below. Other flood plain management techniques should be considered and may well prove to be effective in reducing or preventing flood damages. Many of the road crossings should be resized when replacement is necessary.

Present Condition

This is the "no change" alternative, which reflects ongoing flood plain development pressures and management trends. Local governmental units can continue to plan, zone and accept or reject requests for alternative flood plain and adjacent land uses. Flood problems may continue to increase if development continues.

Land Treatment

This alternative discusses opportunities to minimize or decrease changes in upland runoff and erosion because of land use changes. The traditional approach of accelerating conservation land treatment, by working with landowners to install conservation practices, will minimize soil erosion and reduce runoff. Installation of such measures as tree planting, windbreaks, forest management, permanent vegetative cover and on-site water storage will all reduce runoff, erosion and sedimentation.

As rural areas urbanize, the increase in peak discharges due to more efficient conveyance paths and increased impervious areas can have a significant adverse impact on downstream areas. There is growing interest on the part of planners, developers and the public in protecting downstream areas from induced flood damages that may accompany increased peaks and stages. Planning authorities are proposing local ordinances that restrict the type of development permitted and the impact development can have on the watershed. One of the primary controls that could be imposed is that future-condition discharges cannot exceed present-condition discharges at some predetermined frequency of occurrence at specified points on the channel.

Methods to control runoff in urbanizing areas reduce the volume of runoff, the rate of runoff or both. The effectiveness of any control method depends on the available storage, the outflow rate and the inflow rate. Because a great variety of methods can be used to control peak flows, each method proposed should be evaluated for its effectiveness in the given area.

TABLE 2 - MEASURES FOR REDUCING AND DELAYING URBAN STORM RUNOFF

Area	Reducing Runoff	Delaying Runoff
Parking Lots	<ol style="list-style-type: none"> 1. Porous pavement <ol style="list-style-type: none"> a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches 	<ol style="list-style-type: none"> 1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measure for impervious areas <ol style="list-style-type: none"> a. Rippled pavement b. Depressions c. Basins
Residential	<ol style="list-style-type: none"> 1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Groundwater recharge <ol style="list-style-type: none"> a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions 	<ol style="list-style-type: none"> 1. Reservoir or detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters or diversions

Preservation and Restoration of Natural Values

Flood plains, in their natural or relatively undisturbed state, provide three broad sets of natural and beneficial resources and resource values.

Water resource values include natural moderation of floods, water quality maintenance and groundwater recharge. The physical characteristics of the flood plain shape flood flows. Flood plains generally provide a broad area to spread out and temporarily store flood waters. This reduces flood peaks and velocities and the potential for erosion.

Flood plains serve important functions in protecting the physical, biological and chemical integrity of water. A vegetated flood plain slows the surface runoff, causing it to drop most of its sediment load on the flood plain. Pathogens and toxic substances entering the main water body through surface runoff and accompanying sediments are decreased.

The natural flood plain has surface conditions favoring local ponding and flood detention, plus subsurface conditions favoring infiltration and storage. The slowing of runoff provides additional time for it to infiltrate and recharge available ground water aquifers, and also provides for natural purification of the waters.

Flood plains support large and diverse populations of plants and animals. In addition, they provide habitat and critical sources of energy and nutrients for organisms in adjacent and downstream terrestrial and aquatic ecosystems. The wide variety of plants and animals supported directly and indirectly by flood plains constitutes an extremely valuable, renewable resource important to economic welfare, enjoyment and physical well-being.

The flood plain is biologically important because it is the place where the elements of both terrestrial and aquatic ecosystems mix. Shading of the stream by flood plain vegetation moderates water temperatures; roots and fallen trees provide instream habitat; and near stream vegetation filters runoff, removing some sediments and nutrients, to further enhance instream environments.

Flood plains contain cultural resources important to the nation and to individual localities. Native American settlements and early cities were located along the coasts and rivers in order to have access to water supply, waste disposal and water transportation. Consequently, flood plains include most of the nation's earliest archeological and historical sites. In addition to their historical richness, flood plains may contain invaluable resources for scientific research. For example, where flood plains contain unique ecological habitats, they make excellent areas for scientific study. Flood plains may provide open space community resources. In urban communities, they may provide green belt areas to break urban development monotony, absorb noise, clean the air and lower temperatures. Flood plain parks can also serve as nature study centers and laboratories for outdoor learning experiences.

It is recommended that several selected open space areas be preserved, especially in the undeveloped areas. Their preservation, in accordance with soil limitations and good land use management, will reduce development hazards, prevent additional future flood damages and enhance the urban environment.

Restoration of wetlands can reduce downstream flooding, improve water quality and improve wildlife habitat.

1. Preserve Wetlands - Soils with high water tables should be retained in natural vegetation. No commercial or residential construction should take place on these soils since the limitations are severe. Soils information was obtained from the published soil survey reports for Genesee and Shiawassee Counties. A soil survey report for Saginaw County is currently being prepared. Copies of the soil surveys, including maps and interpretations, are available for reference at: Genesee Soil Conservation District Office located at 1525 North Elms Road, Flint, Michigan 48532; or Saginaw Soil Conservation District Office located at 265 S. Graham Road, Saginaw, Michigan 48603-9423; or Shiawassee County Soil Conservation District Office located at 1767 South M-52, Owosso, Michigan 48867-9201. This information can be used to locate the kinds of soils in a given area and evaluate their limitations for various uses.
2. Preserve Open Space - Upland open space should be retained in the natural state as much as possible.
3. Preserve Woodlands - Wooded areas on steep slopes should be preserved from all development. Destruction of natural cover on these steep slopes usually causes excessive erosion during construction. Preservation of these wooded sites would also enhance housing developments in the area.
4. Provide Onsite Floodwater Storage - Developing areas should provide on-site flood water storage to temporarily store additional runoff volumes and peak flows created by their urbanization.
5. Promote Wildlife Areas and Outdoor Classrooms - Undeveloped flood plain areas should be managed for wildlife and recreation. These areas have potential for an excellent outdoor classroom. The Misteguay Creek system is easily accessible to many school and college students.

Non-Structural Measures

1. Develop and implement, or update, a flood plain protection and zoning ordinance based on the 100-year frequency high water profile and the flood plain delineations (Appendix A). Retaining the storage in the existing flood plain area will be necessary if this flood profile is to remain valid. Reducing the storage capacity in the system will tend to increase elevations and discharges above that indicated in this report.
2. Flood proof buildings and residences already in the flood plain to reduce flood damages. Some basement windows and doors, floor drains and foundations can be modified to reduce effects of flood waters. Materials and supplies stored in vulnerable positions can be relocated and protected. These modifications can be planned and installed where it is desirable and/or feasible to continue using facilities currently in the flood plain.
3. Plans should be developed for alternate routes for automobile, truck and emergency vehicle traffic around those roads that will be inundated during the flood. This will require cooperation between city, township, county and state officials.

4. Maintenance of Misteguay Creek should continue. Debris, fallen trees and brush should be removed at least yearly. Snow and ice from road clearing operations should not be piled in the flood plain. Continued maintenance is needed on the dikes at the lower end of Misteguay Creek. Faulty flap gates need to be replaced when damaged.
5. Owners and occupants of all types of buildings and mobile homes should obtain flood insurance coverage for the structure and contents, especially if located within or adjacent to the delineated flood hazard areas. The Sponsors should make necessary applications and pass needed resolutions and zoning ordinances to qualify for subsidized federal flood insurance. Contact the Land and Water Management Division, Michigan Department of Natural Resources, Mason Building, P.O. Box 30028, Lansing, Michigan 48909 for additional information.
6. Flood Evacuation Standard Operating Procedures have been prepared for Saginaw and Shiawassee Counties for areas along Misteguay Creek in the event of dam failure and are available from: County Emergency Services, 111 S. Michigan, Saginaw, Michigan 48606 (telephone - (517) 790-5434) or Emergency Services Director, 701 S. Norton, Corunna, Michigan 48817 (telephone - (517) 743-2229).

Structural Measures

The designs for the following structural alternatives are preliminary only. Additional engineering analysis and final cost estimates would need to be made should the Sponsors elect to install any or all of the following alternatives:

1. Current Design Criteria

Technical Release No. 60, Earth Dams and Reservoirs, revised October 1985, published by USDA Soil Conservation Service describes design procedures and provides minimum requirements for planning and designing earth dams and associated spillways. The structures were designed as Class A structures in the 1960's. Class A structures are dams located in rural or agricultural areas where failure may damage farm buildings, agricultural land or township and county roads, but not pose a threat to loss of life.

Subdivisions, apartment buildings and residential homes have been built below the dams since they were constructed in the 1960's. Consequently, the dams are now Class C structures. Class C structures are dams located where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads.

According to TR-60, a storm duration of not less than 10 days is to be used for sizing the principal spillway. Accordingly, the minimum principal spillway hydrologic criteria for those Class C dams is the runoff from an 100-year storm. The 100-year, 10-day runoff is 6.8 inches, shown in Figure 2-1 (A) of TR-60, and the 100-year, 1-day runoff is 2.72 inches, as calculated from Figure 2-1 (B). In addition, a quick return flow of 4 csm, as shown in Figure 2-1 (C) of TR-60, must be added to the principal spillway hydrograph.

The Soil Conservation Service's TR-48, Dam 2, Structure Site Analysis Computer Program, dated March 1984, was used to model the existing three dams in series. The convex routing method was used for the channel routings between structures. The Go-Design Option of the TR-48 model sets the emergency spillway crest elevation based on the 100-year 10-day runoff and quick return flow. Required emergency spillway crest elevations were determined with the existing stage-discharge-storage curves of the principal spillways of the three dams in series. The required emergency spillway crests would need to be set several feet above the existing emergency spillway crests. Consequently, the three dams do not meet current design criteria for principal spillways. Additional TR-48 runs were made with revised stage-discharge-storage curves to include the existing emergency spillway flows as principal spillway flow and it was estimated that Structure 4 would experience 4.0 feet of flow in its emergency spillway, Structure 3A would have 2.3 feet of flow in its emergency spillway and Structure 2's emergency spillway would have 1.5 feet of flow.

In addition to checking the existing three dams in series with the current criteria as stated in TR-60 for the minimum principle spillway criteria, the minimum emergency spillway hydrologic criteria was checked using TR-20. According to Table 2-5 of TR-60, the emergency spillway must pass 10.0 inches of rainfall. The emergency spillway hydrograph tops Structure 2 by 0.8 feet, Structure 3 by 3.4 feet and Structure 4 by 3.3 feet. The assumed stage-discharge-storage curves included emergency spillway flow in the principal spillways. The three dams in series do not meet TR-60 requirements for emergency spillway flow.

Finally, TR-60 mandates that the Probable Maximum Precipitation (PMP) storm will not top a dam. A TR-20 computer run was made with the PMP storm, which was equal to 23.8 inches of rainfall over 24 hours. The PMP storm topped all three structures by several feet. The three dams in series do not meet current TR-60 criteria for PMP storms.

2. Dike Capacity

The capacity of the existing dikes from the Flint River to West Burt Road, approximately 6.6 miles, is a 25-year flood. A considerable amount of work on the dikes and road crossings would be required to increase dike capacity to handle a 50-year flood. Any measures made to increase peak discharges out of Structure 4 would increase flood elevations below Structure 4 and additional engineering analysis would be required.

3. Additional Dams

A cursory map review and limited analysis was done to determine if additional structures could help alleviate the flooding problems. It was determined there were inadequate storage sites available on either the Northwood Creek or Porter Creek. No other potential dam sites were located.

4. Emergency Spillways

Mechanical treatment of the emergency spillways of the three dams could reduce the chance of dam failure in the event of frequent emergency spillway flow. Rock riprap, concrete or a combination of concrete and vegetation are possible alternatives to vegetation only. Stable structures would need to be installed at the outlets of the emergency spillways to prevent downstream erosion. It should be noted that this structural alternative would not meet current TR-60 design criteria because the existing emergency spillways are set too low.

5. Increase Fill Height of Structures 3A and 4

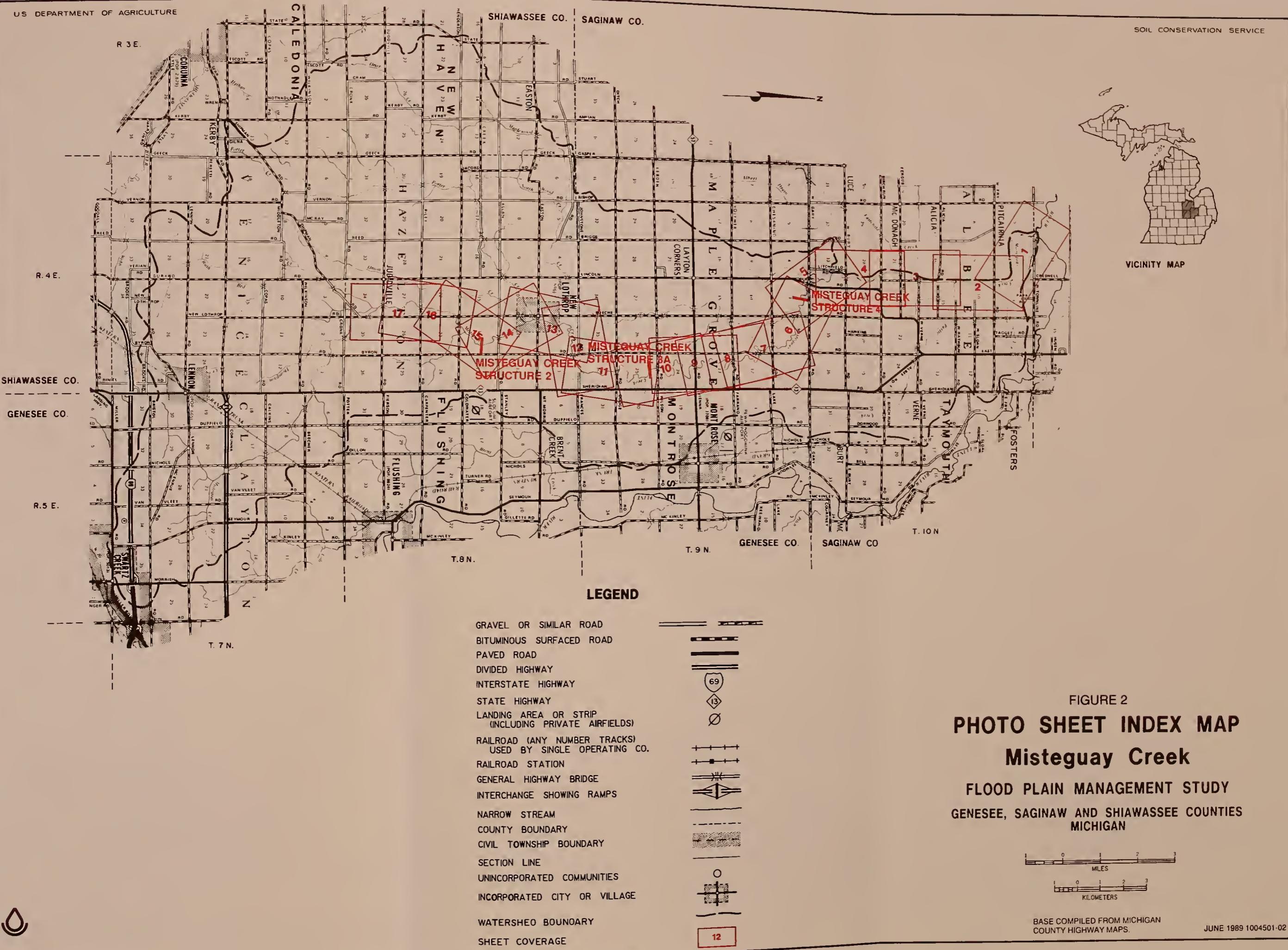
A breach analysis for the three dams in series was completed. Breach water surface profiles are shown in separate reports, Flood Evacuation Standard Operating Procedures for Shiawassee and Saginaw Counties. The breach water surface profile tops Structure 3A by 0.5 feet and Structure 4 by 0.7 feet. In conjunction with mechanically treating the existing emergency spillways, consideration could be given to raising the tops of Structures 3A and 4 by approximately 1 foot. This would reduce the risk of dam failure by preventing overtopping in the event of Structures 2 and 3A breaches.

6. Trash and Debris Problems Above Structure 4

The accumulation of debris and trash above Structure 4 has been a continual maintenance problem. The twin 36-inch drawdown drains plug regularly with trash and debris, resulting in water ponding behind Structure 4 to approximate elevation 608.0. This causes a slight reduction in actual available storage capacity; however, it should be noted that the original design calculations assumed that sediment would accumulate to elevation 608.0 during the life of the project and additional storage below elevation 608.0 was not considered.

An enlarged drawdown tube with a trash removal device will provide increased low flow capacities for Structure 4. However, as stages increase in the reservoir, the riser is loaded and the outlet conduits begin to flow full. The enlarged drawdown tube will then add no additional capacity to the outflow from the structure. Initial early higher outflows will reduce stages in the reservoir, but these effects on peak stages are estimated to be minimal due to the volume of storage below elevation 608.0. Detailed hydraulic computations are needed to establish a revised elevation-discharge curve considering submergence of the drawdown tube and orifices. Additional flood routings from Structure 4 would be needed to determine changes in flood elevations since the purpose of this type of riser was to restrict flow for frequent storm events such that downstream in-bank stream capacity is not exceeded.

APPENDIX A



VALLEY SECTIONS

ELEVATION ABOVE MEAN SEA LEVEL
IN FEET
NATIONAL GEODETIC VERTICAL DATUM of 1929

600

590

580

570

0+00

10+00

20+00

30+00

40+00

50+00

60+00

70+00

80+00

90+00

600

590

580

570

TOP OF DIKE

LOW GROUND

EXISTING CHANNEL BOTTOM

STATIONS ALONG CENTERLINE
IN FEET

NOTE:

Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

NOTE:

Starting Flood Elevations from 1976 Spaulding Township Flood Insurance Study.

BRIDGE DECK

ROAD OVERFLOW

BRIDGE LOW CHORD

HIGH WATER PROFILES

MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed T.D. BOURDON	Date 12-88	Approved By Title
Drawn L.A. WILSON		
Traced R.H. BAUERLE	12-88	Title Sheet No 1 Drawing No of 17



LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 8.0 Valley Section Location

Stream Channel

TBM 9.1 Temporary Bench Mark

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM
ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION.

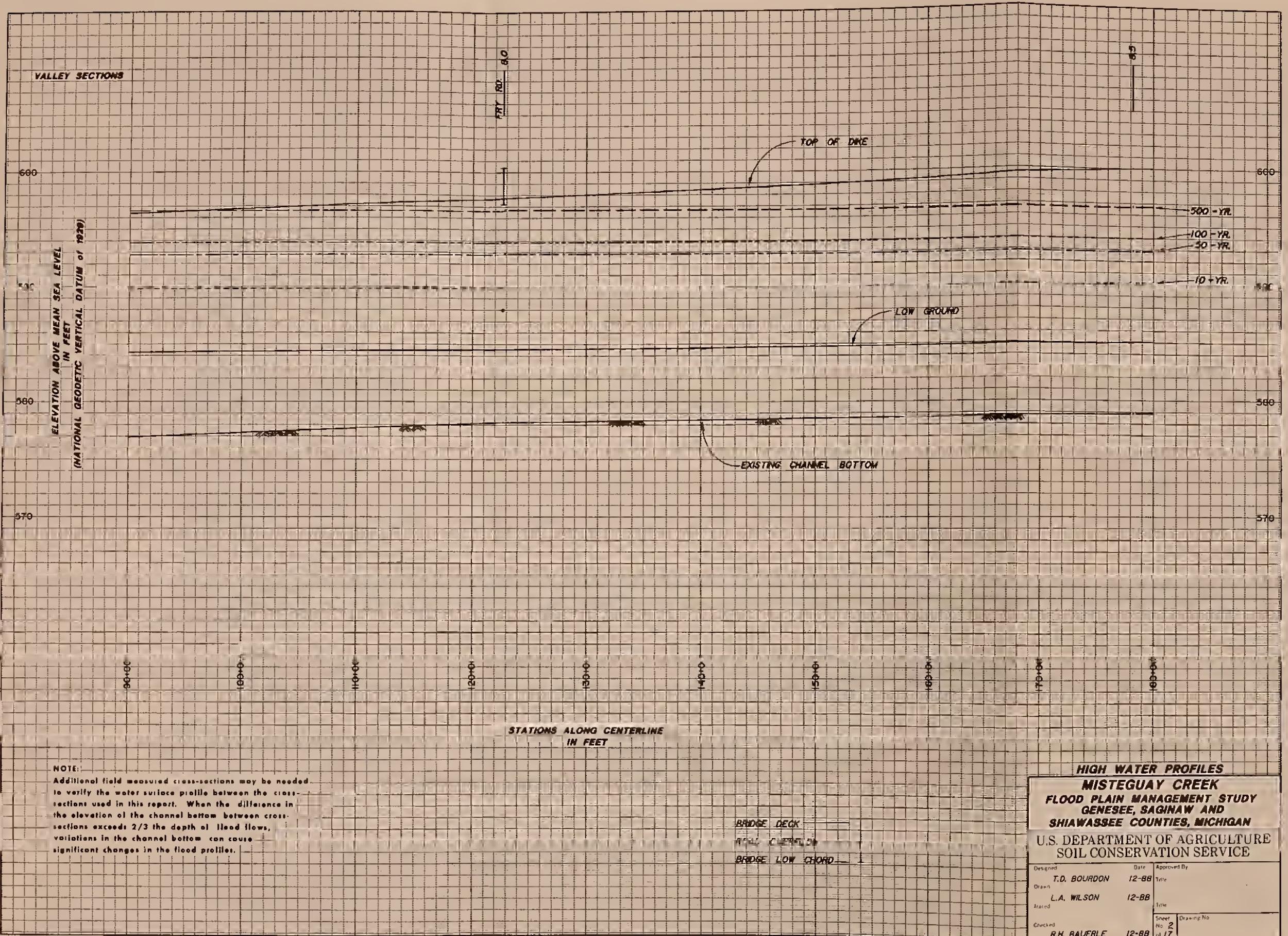
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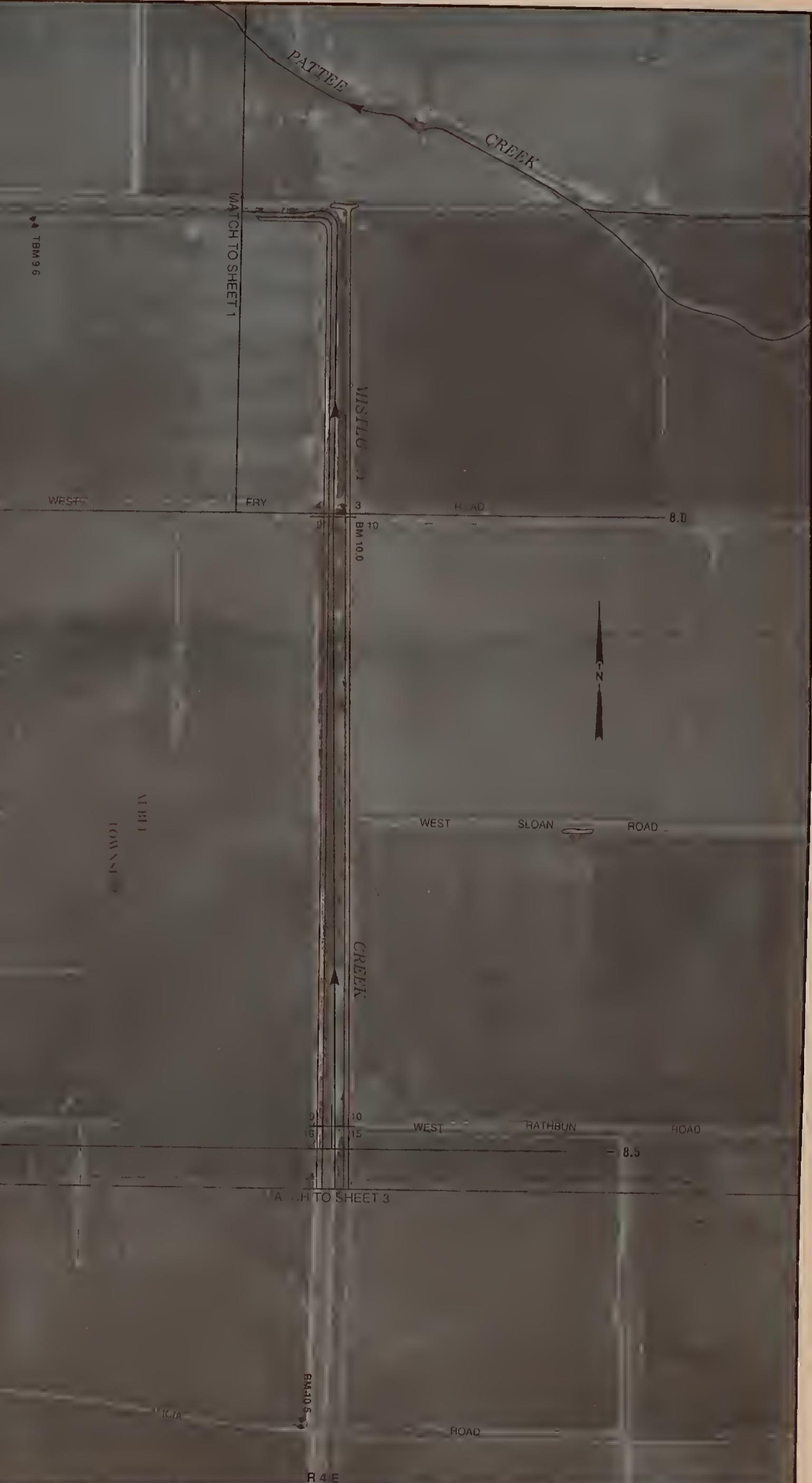
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MICHIGAN

FLOOD HAZARD AREA

MISTEGUAY CREEK





LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

Stream Channel

TBM 9.1 Temporary Bench Mark

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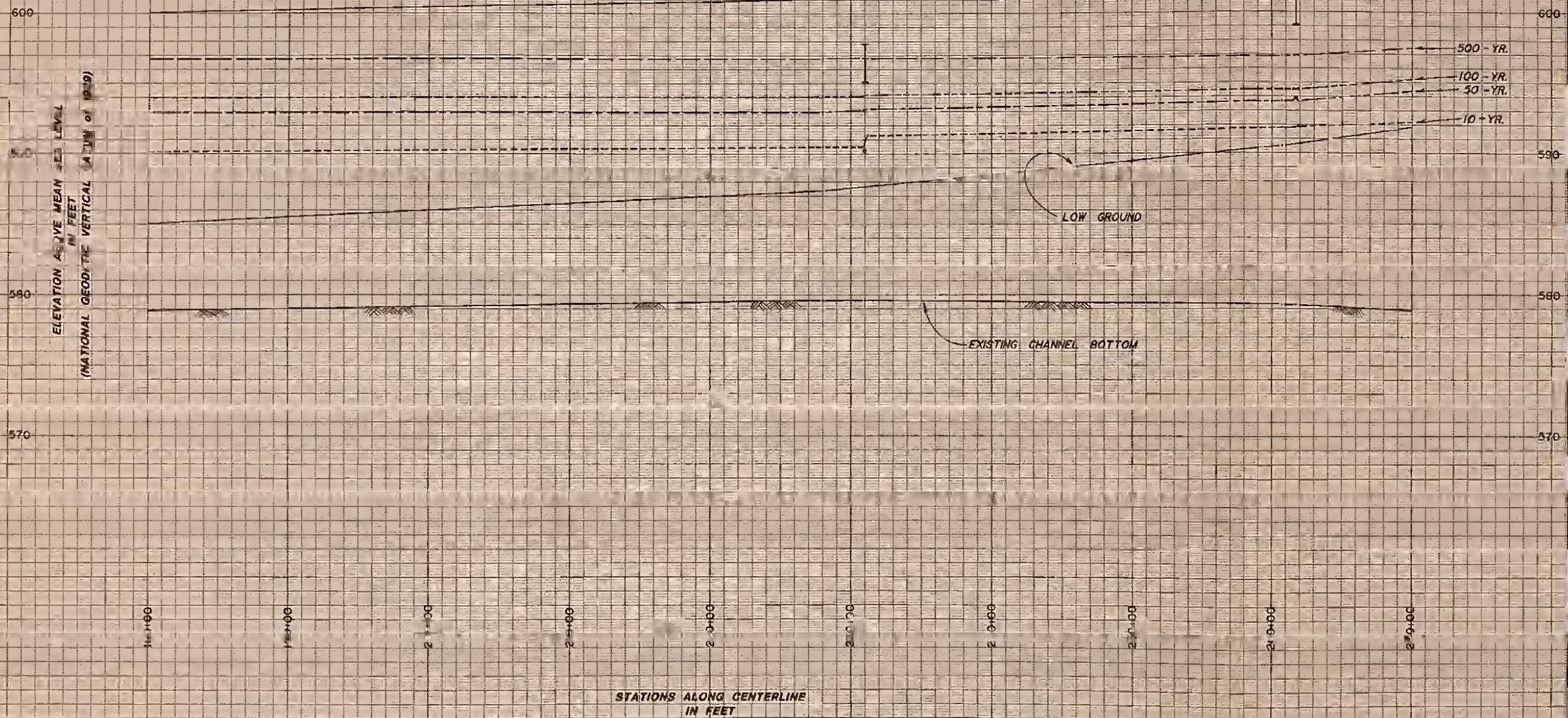
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MICHIGAN

FLOOD HAZARD AREA

MISTEGUAY CREEK

VALLEY SECTIONS

ELEVATION ABOVE MEAN SEA LEVEL
IN FEET
(NATIONAL GEODETIC VERTICAL datum of 1929)



NOTE:
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STATIONS ALONG CENTERLINE
IN FEET

BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD

HIGH WATER PROFILES
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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Traced R.H. BAUERLE	12-88	
Checked R.H. BAUERLE	12-88	Drawing No. cl 17

**LEGEND**

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

Stream Channel
 TBM 9.1 Temporary Bench Mark

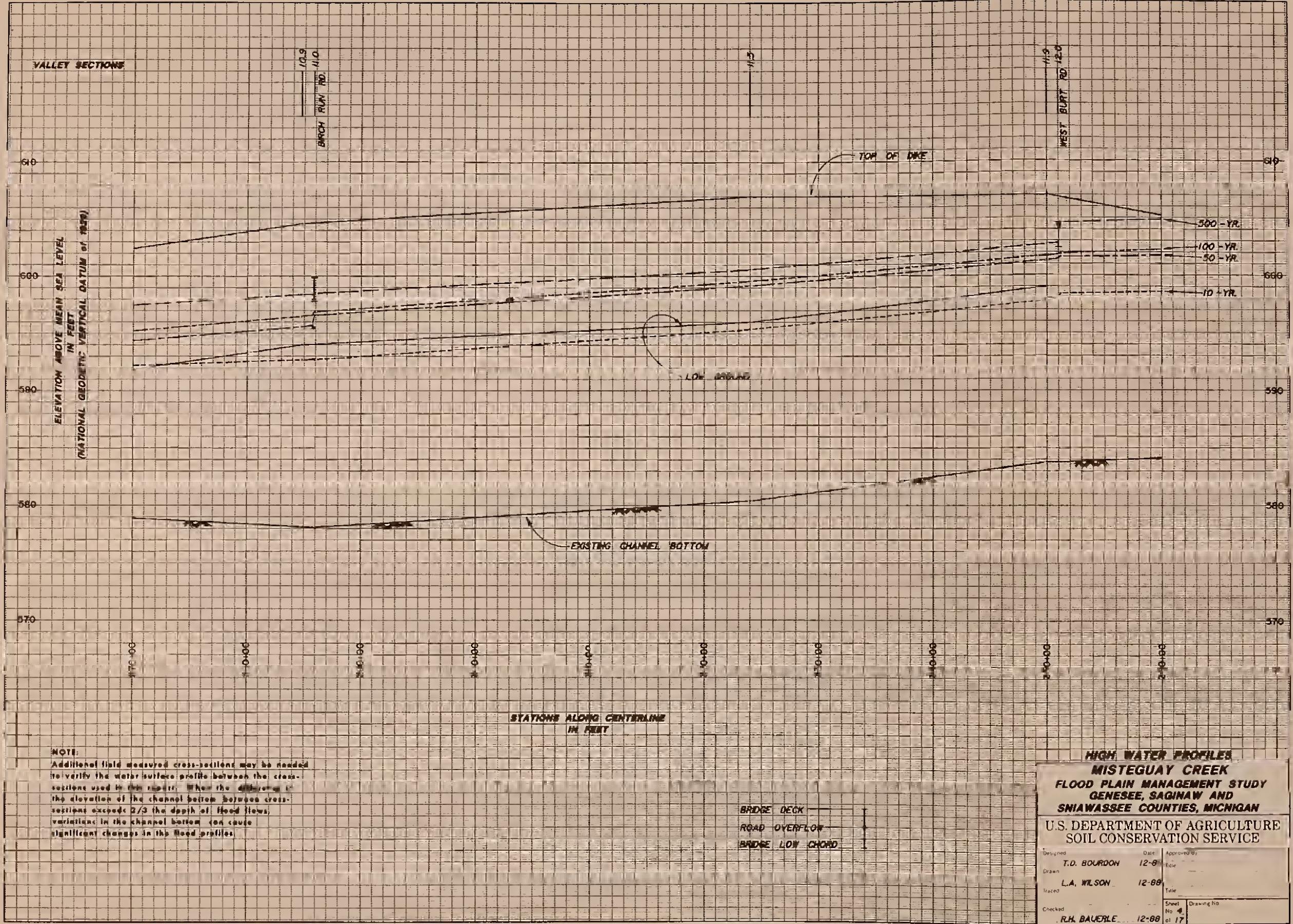
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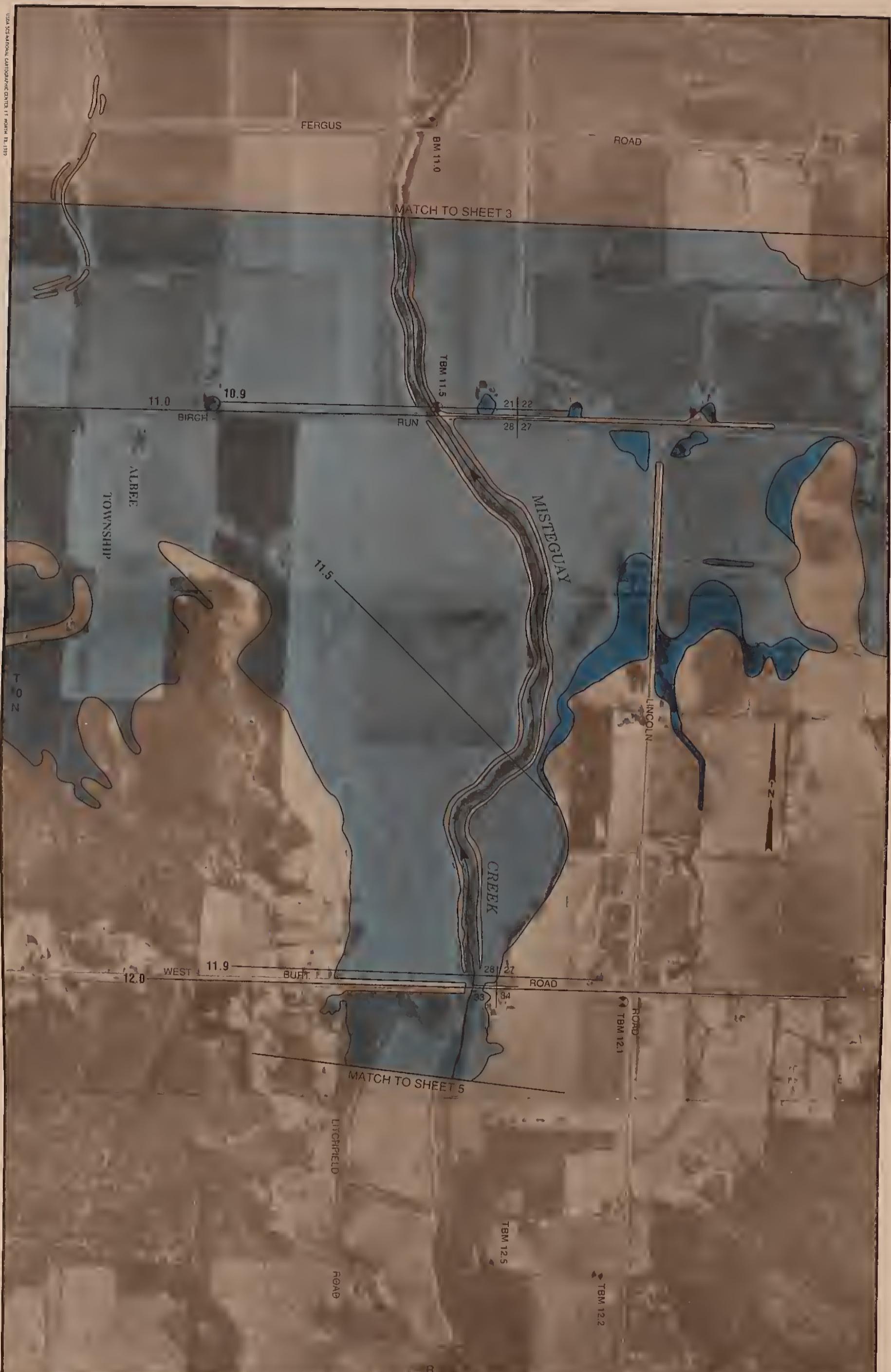
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FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA**MISTEGUAY CREEK**



**LEGEND**

- 100 Year Flood Hazard Area
- Stream Channel
- 500 Year Flood Hazard Area
- Temporary Bench Mark
- Valley Section Location

TBM 9.1

NOTE:
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SCALE
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0 200 400 METERS

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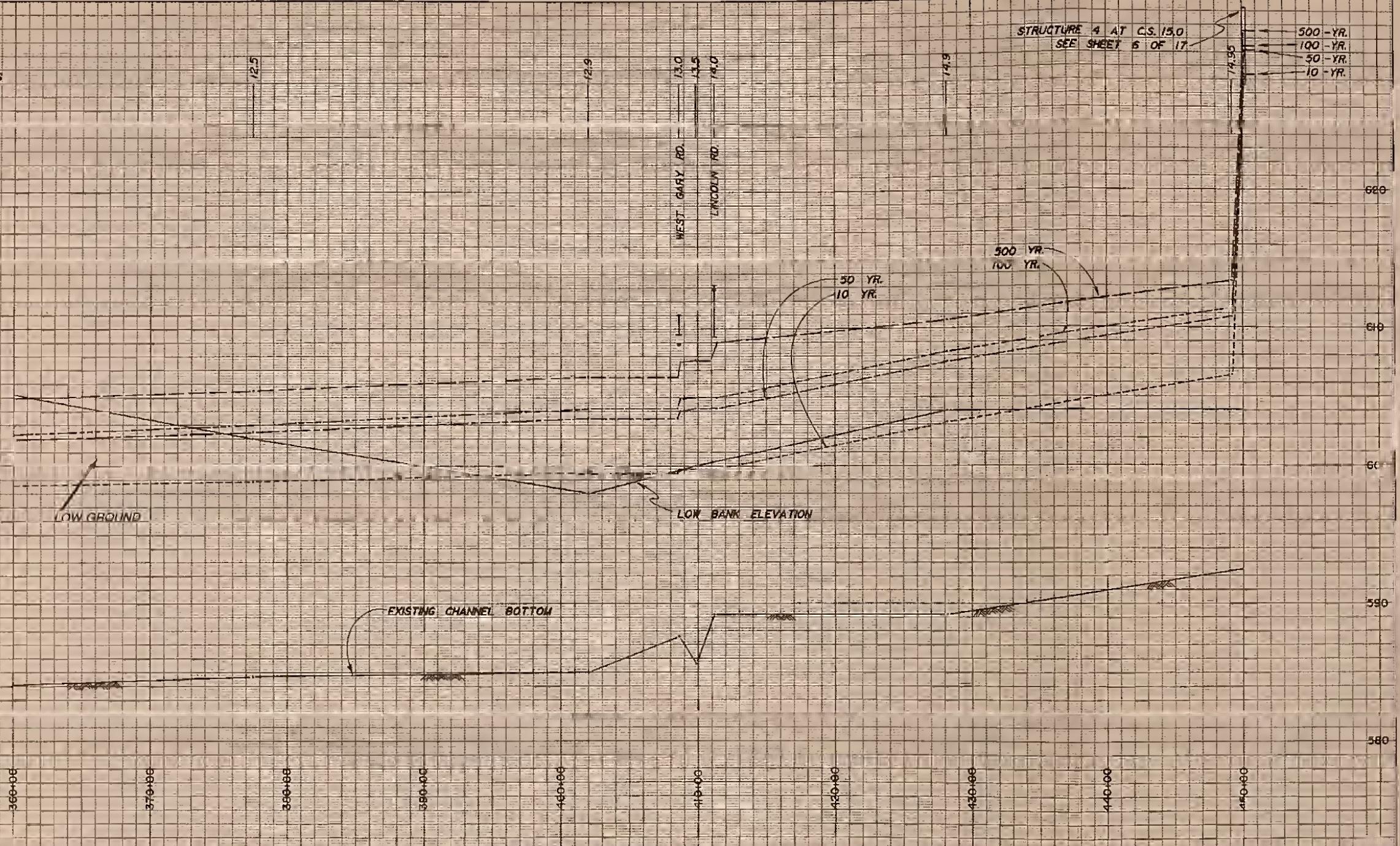
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FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA**MISTEGUAY CREEK**

VALLEY SECTIONS

ELEVATION ABOVE MEAN SEA LEVEL
IN FEET
NATIONAL GEODAATIC VERTICAL DATUM of 1929



NOTE:

Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

STATIONS ALONG CENTERLINE
IN FEET

BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD

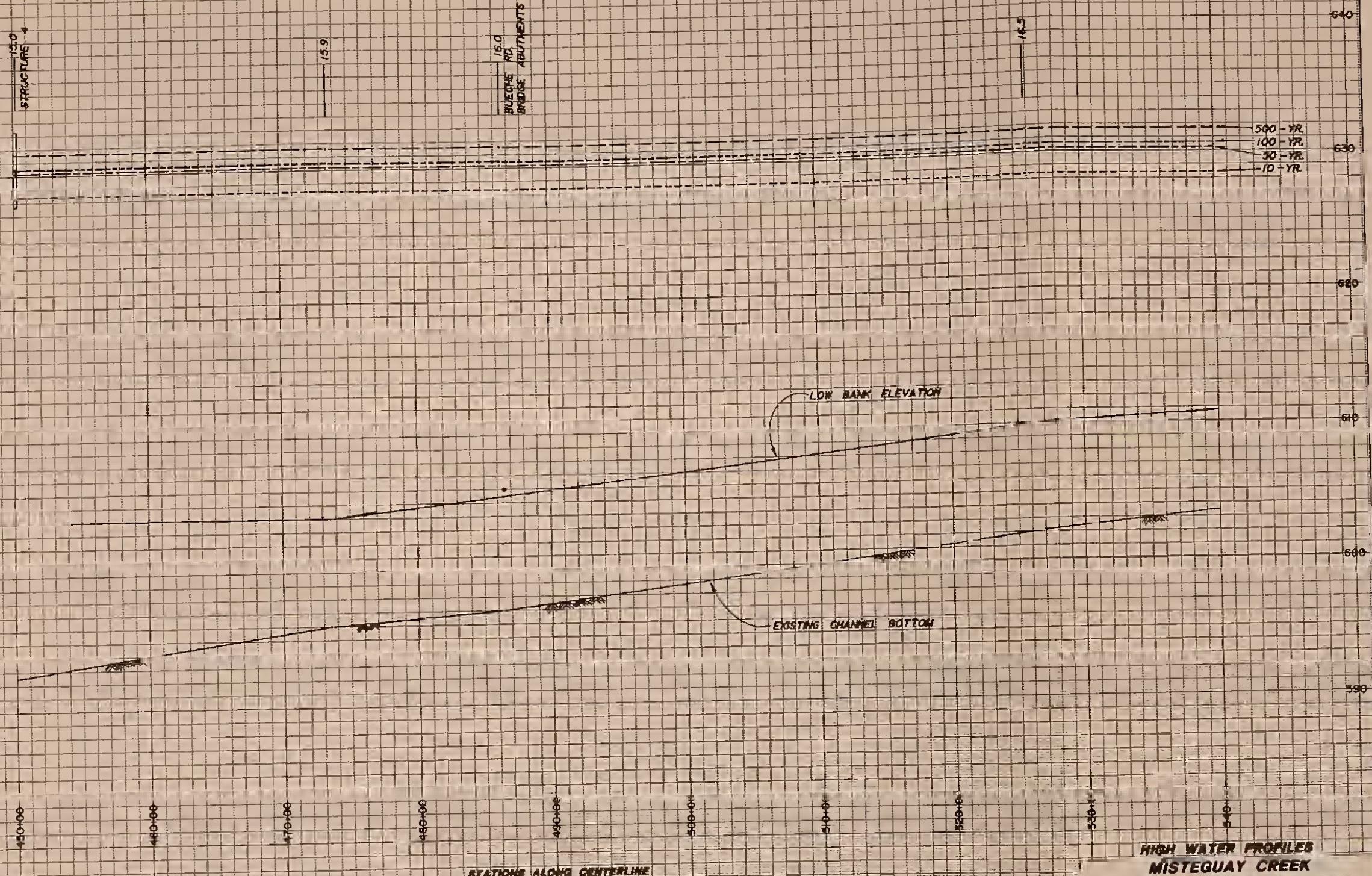
HIGH WATER PROFILES
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN

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L.A. WILSON	12-88	Title
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R.H. BAUERLE	12-88	Drawing No Sheet No 5 of 17



ELEVATION ABOVE MEAN SEA LEVEL
IN FEET
NATIONAL GEODETIC VERTICAL DATUM of 1929



NOTE:
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STATIONS ALONG CENTERLINE
IN FEET

BRIDGE DECK
ROAD OVERLAIN
BRIDGE LOW CHORD
TOP OF BANK
EMERGENCY SPILLWAY

HIGH WATER PROFILES
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN

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T.D. BOURDON L.A. WILSON R.H. BAUERLE		



LEGEND

100 Year Flood Hazard Area

Stream Channel

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM
ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION.

500 Year Flood Hazard Area

TBM 9.1 Temporary Bench Mark

8.0 Valley Section Location

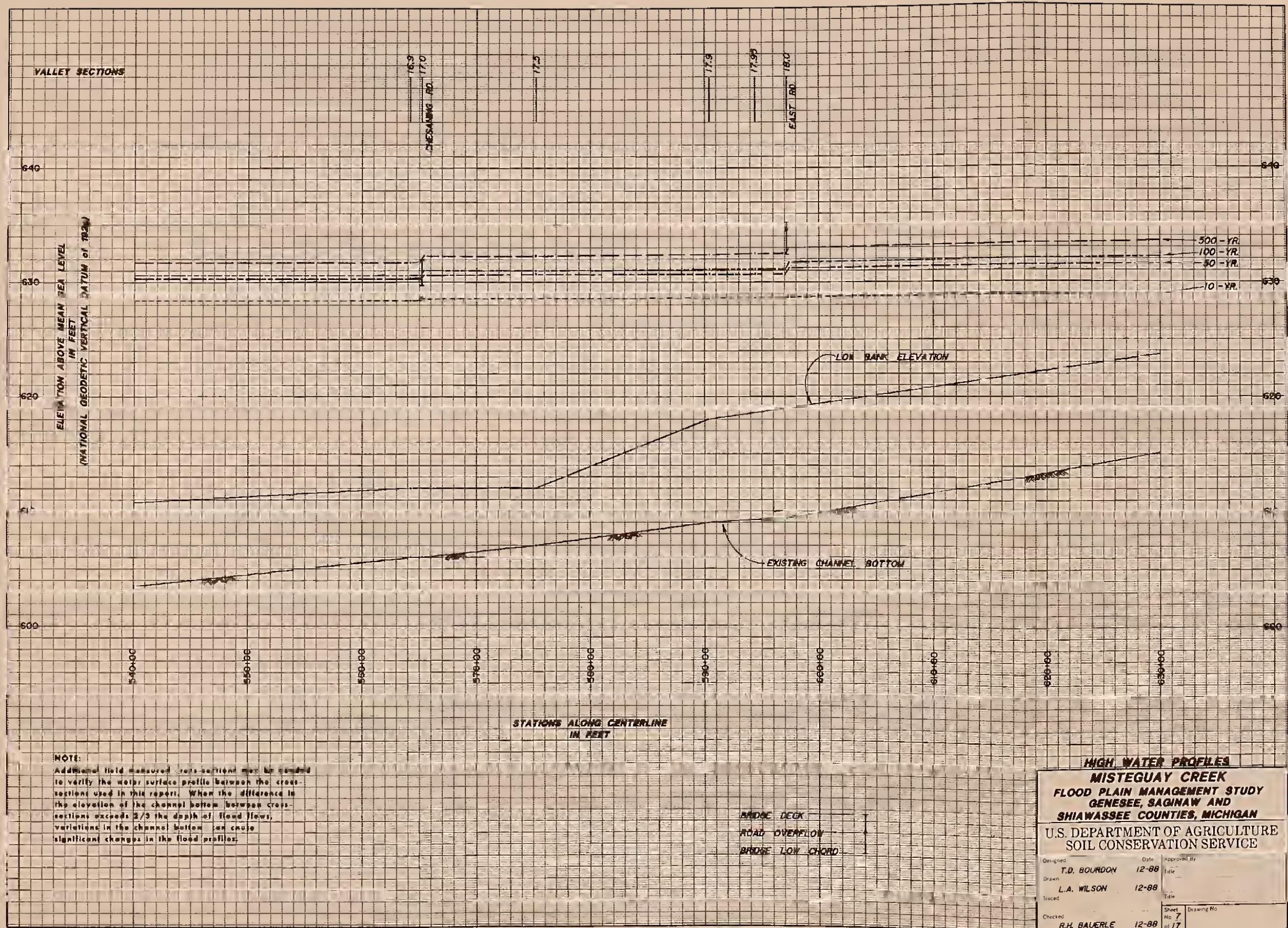
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MISTEGUAY CREEK
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GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA

MISTEGUAY CREEK



NOTE:
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HIGH WATER PROFILES
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN

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LEGEND

100 Year Flood Hazard Area

Stream Channel

500 Year Flood Hazard Area

TBM 9.1 Temporary Bench Mark

8.0 Valley Section Location

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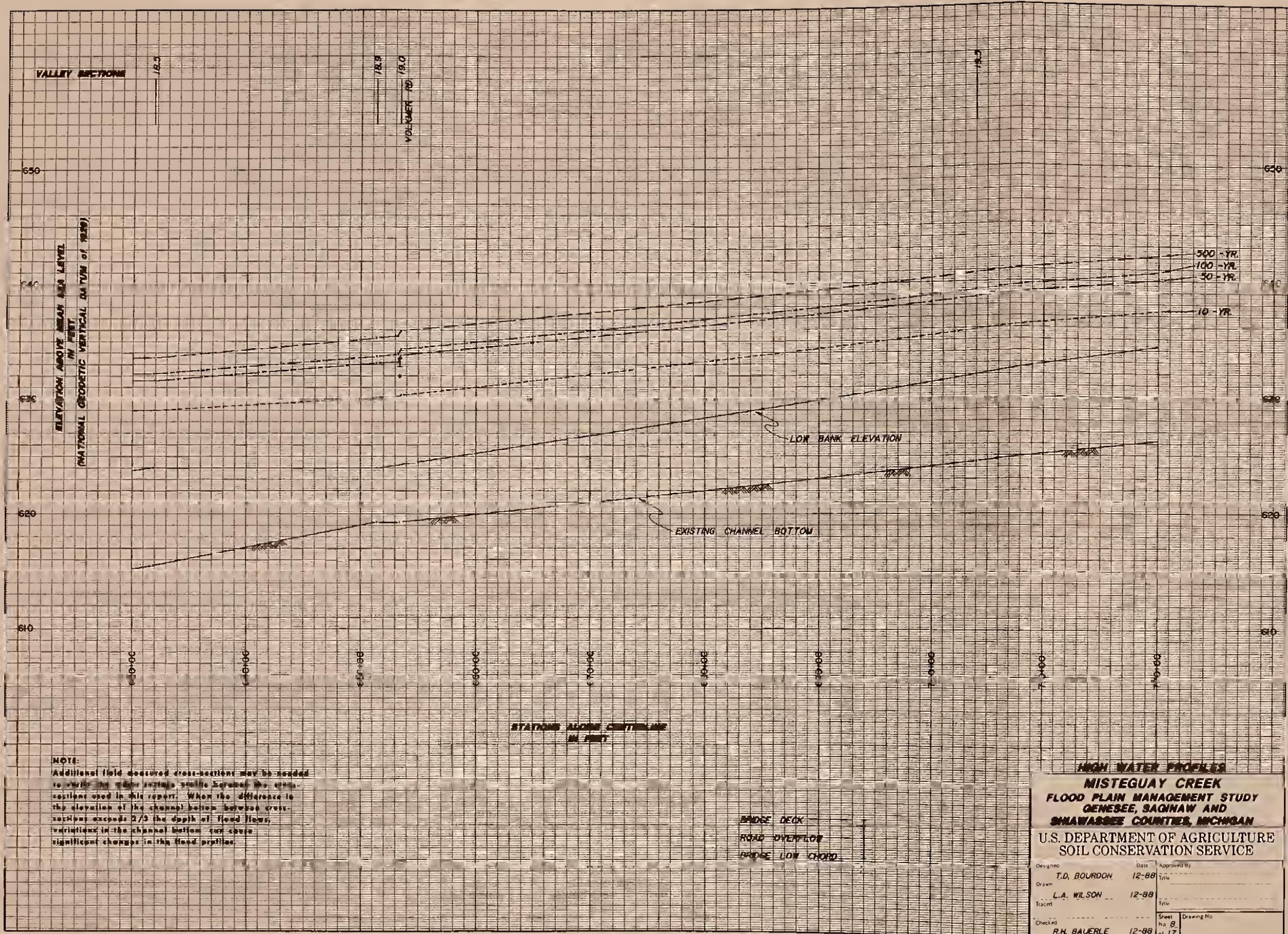
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FLOOD HAZARD AREA

MISTEGUAY CREEK

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MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN



STATION 1800 S. 11 1/2 W.

610 ft

BRIDGE DECK
 ROAD OVERLOR
 BRIDGE LOW CHORD

HIGH WATER PROFILES
MISTEGUAY CREEK
 FLOOD PLAIN MANAGEMENT STUDY
 GENESSEE, SAGINAW AND
 SHIAWASSEE COUNTIES, MICHIGAN

U.S. DEPARTMENT OF AGRICULTURE
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Checked R.H. BAUERLE	12-88	Drawing No. Sheet No. 8 of 17

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LEGEND

100 Year Flood Hazard Area

Stream Channel

500 Year Flood Hazard Area

Temporary Bench Mark

8.0 Valley Section Location

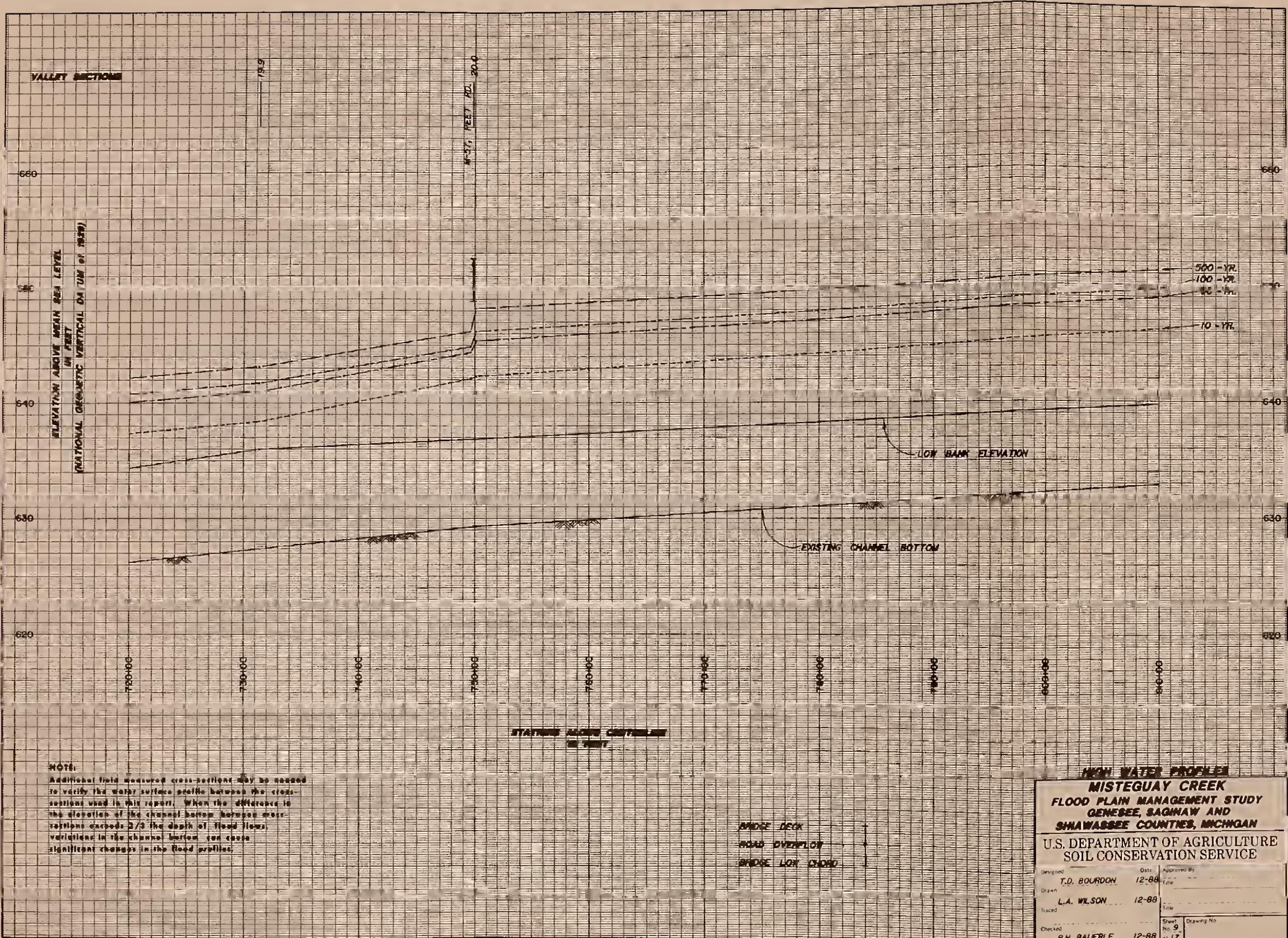
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SCALE 0 800 1600 FEET
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MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA
MISTEGUAY CREEK



詩言

Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross-sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profile.

Elton John

**BOARD DECK
ROAD DIVISION
SUSIE LOW CHAD**

**HIGH WATER PROFILE
MISTEGUAY CREEK
DO PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
WASHTENAW COUNTIES, MICHIGAN**

**U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE**

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Traced		
Checked		
P.M. BAILEY	12-88	Sheet No. 9 Drawing No. 17

**LEGEND**

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

Stream Channel

Temporary Bench Mark

TBM 9.1

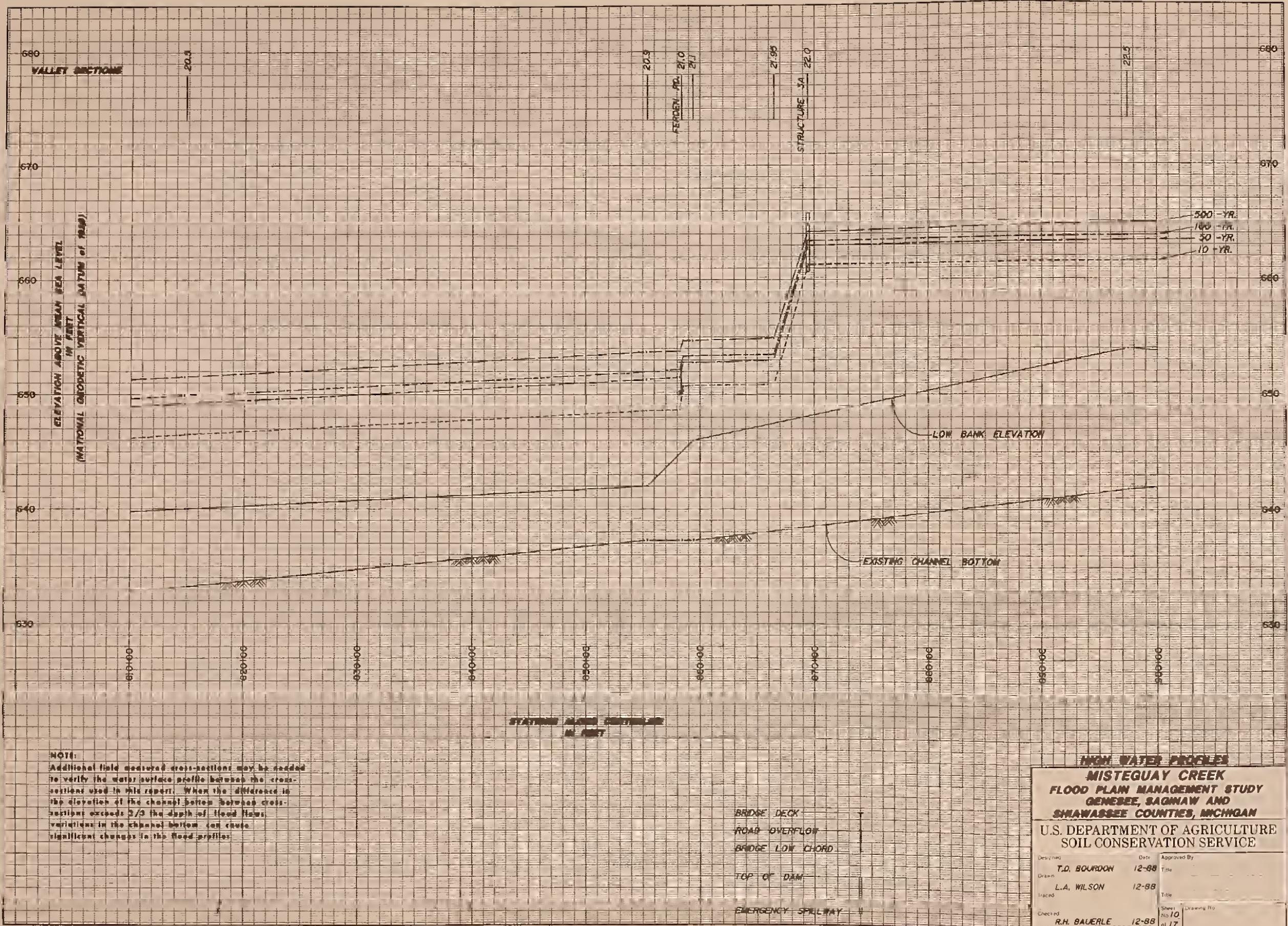
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0 200 400 METERS
0 800 1600 FEET
APPROXIMATE

January 3, 1988 Photography From
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FLOOD HAZARD AREA**MISTEGUAY CREEK**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN





LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

Stream Channel

TBM 9.1 Temporary Bench Mark

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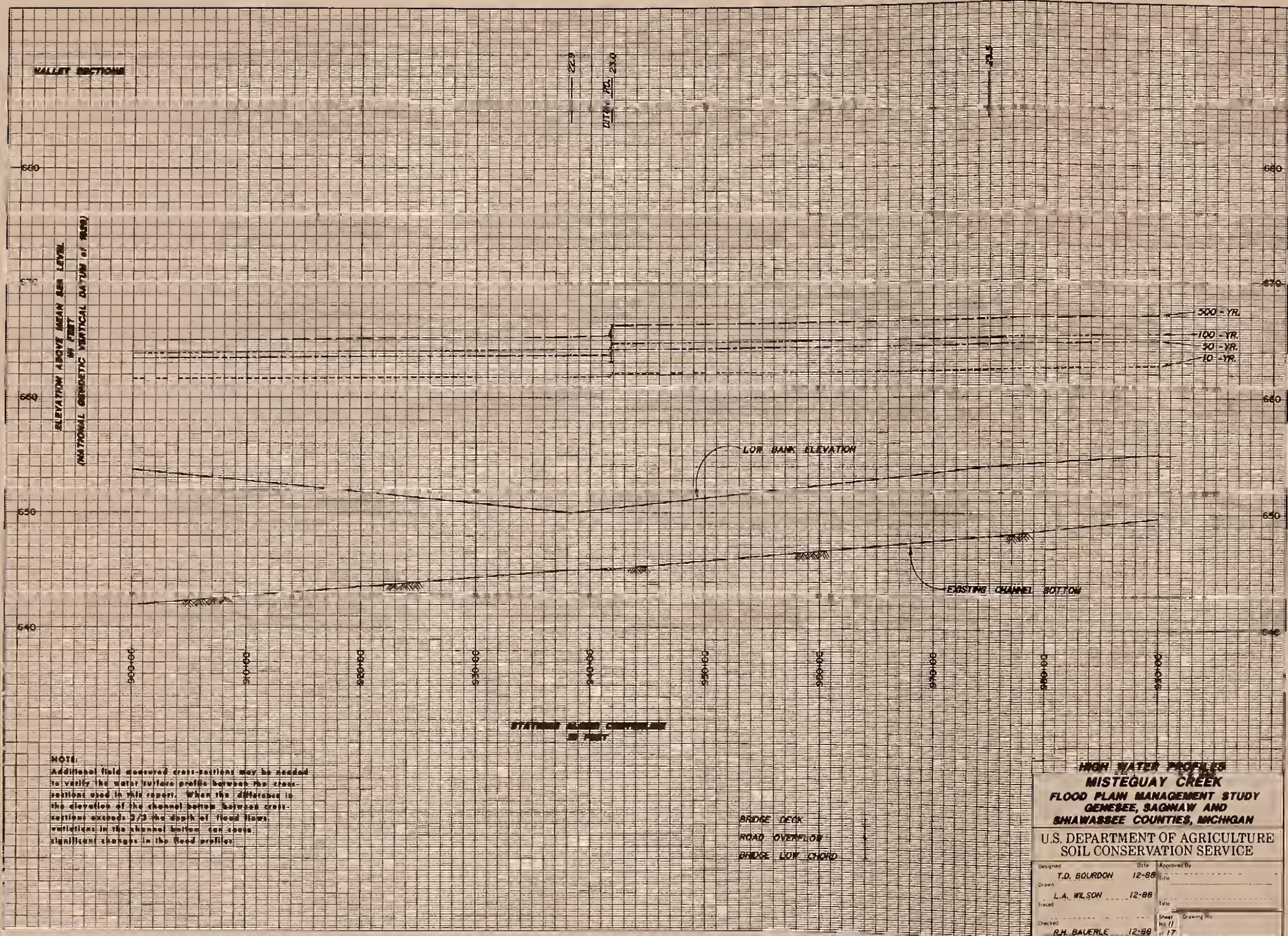
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MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA

MISTEGUAY CREEK



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**HIGH WATER PROBLEMS
MISTEGUAY CREEK
D PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
WASHTENAW COUNTIES, MICHIGAN**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By
T.D. BOURDON	12-88	
Drawn		Date
L.A. WILSON	12-88	
Checked		Date
Specified		Sheet Drawing No
R.H. BAUERLE	12-88	Page No. 11
		of 17

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LEGEND

- LEGEND**

100 Year Flood Hazard Area	Stream Channel
500 Year Flood Hazard Area	TBM 9.1 Temporary Bench Mark
8.0	Valley Section Location

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM
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SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES.**

FLOOD HAZARD AREA

MISTEGUAY CREEK

VALLEY ELEVATION

680

680

ELEVATION ABOVE Mean Sea Level
in FEET
(NATIONAL GEODSTATIC HEIGHTS AT GARTHUR or more)

570

500 - YR.

560

100 - YR.

550

30 - YR.

640

10 - YR.

630

630

100-999

1000

1000

1000

1000

1000

1000

1000

1000

1000

BRIDGE NO. 2239
NOTE: BRIDGE CLOSED
SOUTH 1/2 DECK MISSING

LOW BANK ELEVATION

EXISTING CHANNEL BOTTOM

NOTE:
Additional field measured cross-sections may be needed
to verify the water surface profile between the cross-
sections used in this report. When the difference in
the elevation of the channel bottom between cross-
sections exceeds 2/3 the depth of flood flows,
variations in the channel bottom can cause
significant changes in the flood profiles.

BRIDGE DECK
ROAD OVERFLOW
BRIDGE LOW CHORD

HIGH WATER PROFILE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHAWASSEE COUNTIES, MICHIGAN
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved By
T.D. BOURDON	12-88	_____ Title _____
Drawn		
L.A. WILSON	12-88	
Traced		
Checked		
R.H. BAUERLE	12-88	Sheet No. 12 Drawing No. of 17

R 5 E

**LEGEND**

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

Stream Channel

Temporary Bench Mark

TBM 9.1

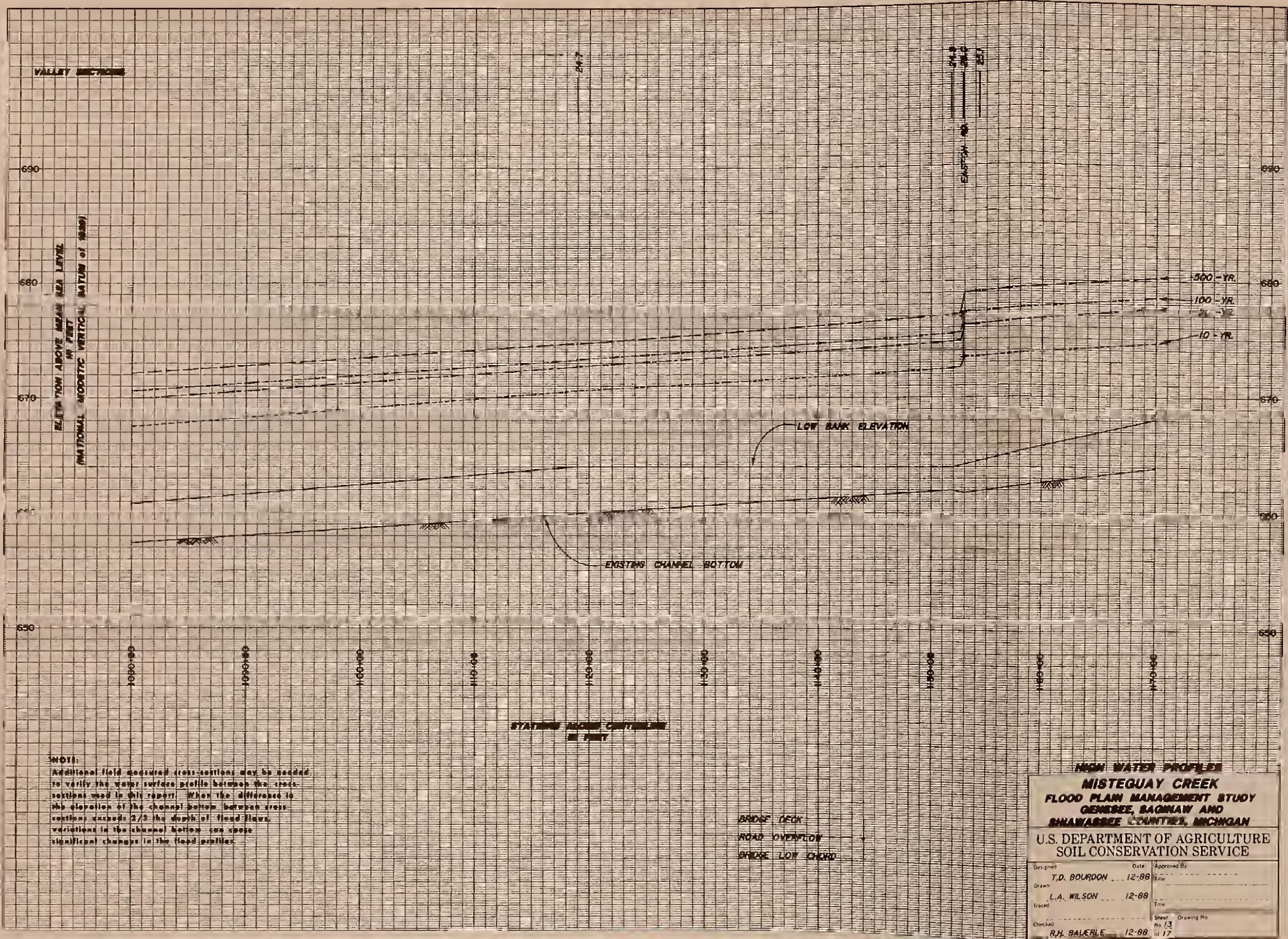
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LIMITS OF FLOODING SHOWN MAY VARY FROM
ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION.

SCALE
0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

January 3, 1988 Photography From
Abrams Aerial Survey Corp.

FLOOD HAZARD AREA**MISTEGUAY CREEK**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN



NOTE: Additional field measured cross-sections may be needed to verify the water surface profile between the cross-sections used in this report. When the difference in the elevation of the channel bottom between cross sections exceeds 2/3 the depth of flood flows, variations in the channel bottom can cause significant changes in the flood profiles.

BRIDGE DECK
ROAD OVERLAYS
BRIDGE LOW CHORD

**MICHIGAN WATER PROFILE
MISTEGUAY CREEK
DO PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
WASHTENAW COUNTIES, MICHIGAN**

**U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE**

Designed	Date	Approved By
<u>T.D. BOURDON</u>	<u>12-88</u>	
Drawn		Title
<u>L.A. WILSON</u>	<u>12-88</u>	
Traced		Title
Checked		Sheet Drawing No
<u>R.H. BAUERLE</u>	<u>12-88</u>	No. <u>13</u> of <u>17</u>

T 9 N

**LEGEND**

100 Year Flood Hazard Area

Stream Channel

500 Year Flood Hazard Area

Temporary Bench Mark

8.0

Valley Section Location

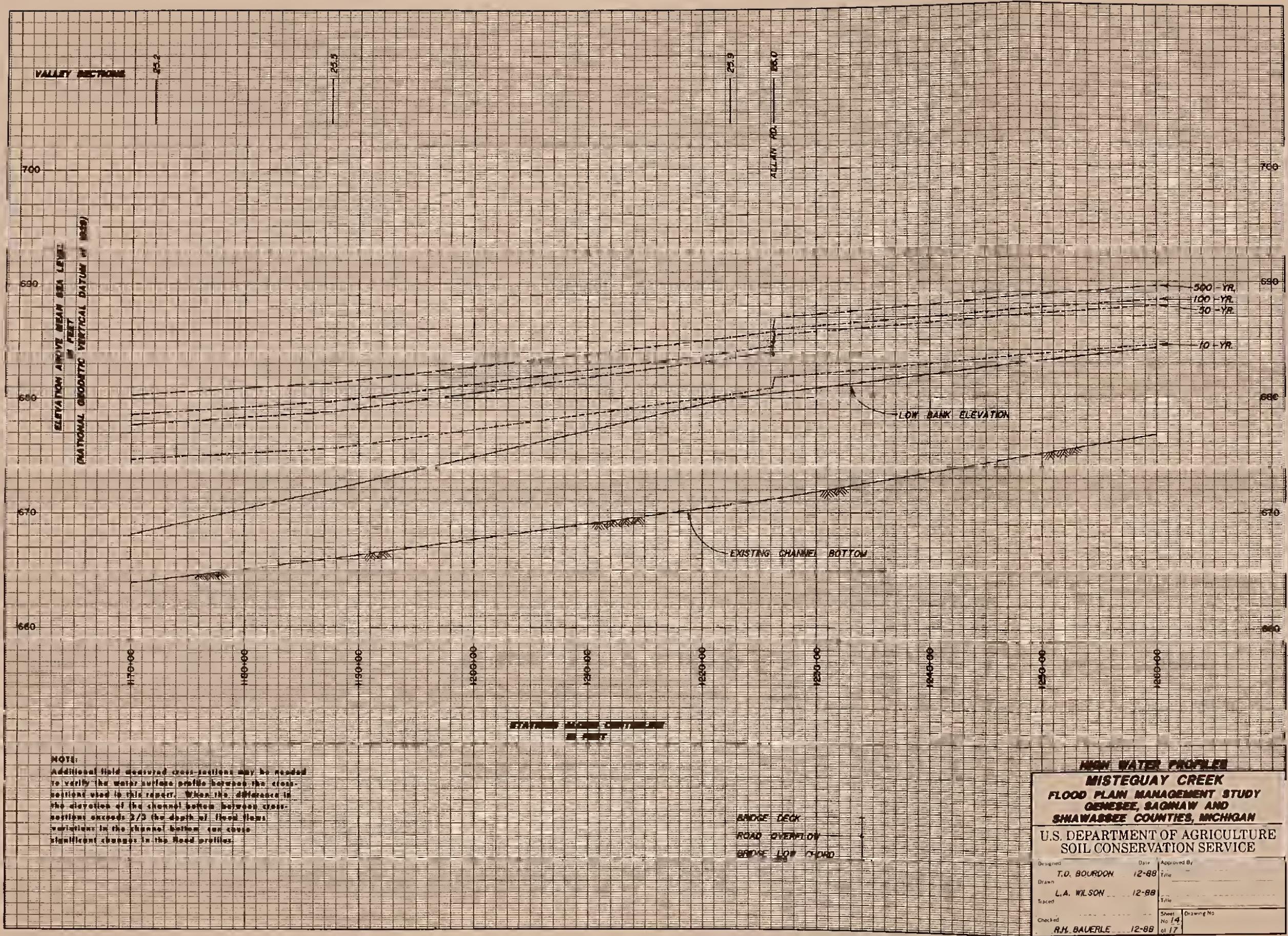
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ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION.

SCALE: 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

January 3, 1988 Photography From
Abrams Aerial Survey Corp.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

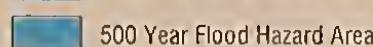
FLOOD HAZARD AREA**MISTEGUAY CREEK**





LEGEND

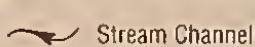
100 Year Flood Hazard Area



8.0 Valley Section Location

8.0 Valley Section Location

Valley Section Location



TRM 8.1 Temporary Bend

TBM 9.1 Temporary Benefit Mark

卷之三

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM
ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION

0 800 1600 FEET
 SCALE 0 200 400 METERS
 APPROXIMATE

January 3, 1988 Photography From
Abrams Aerial Survey Corp.

**U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN**

Abrams Aerial

MISTEGUAY CREEK

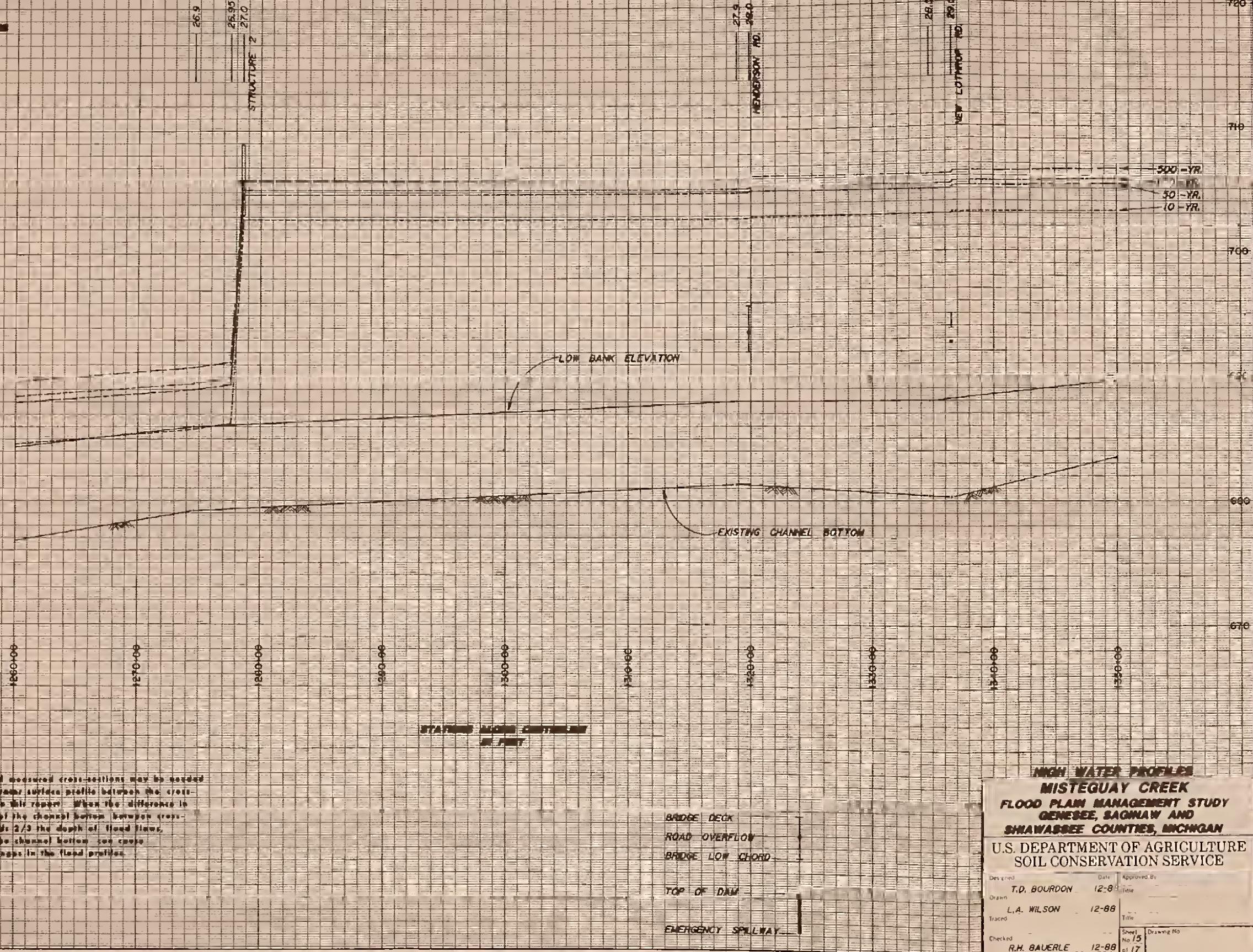
230

VALVE **OPEN**

STATION ABOVE MEAN SEA LEVEL

CHAPTER EIGHT

ପ୍ରକାଶକ ମେଟ୍ରିକ୍



**LEGEND**

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

- ~ Stream Channel
- ◆ Temporary Bench Mark
- ◆ TBM 9.1

NOTE:
LIMITS OF FLOODING SHOWN MAY VARY FROM
ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION.

0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

January 3, 1988 Photography From
Abrams Aerial Survey Corp.

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23
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21

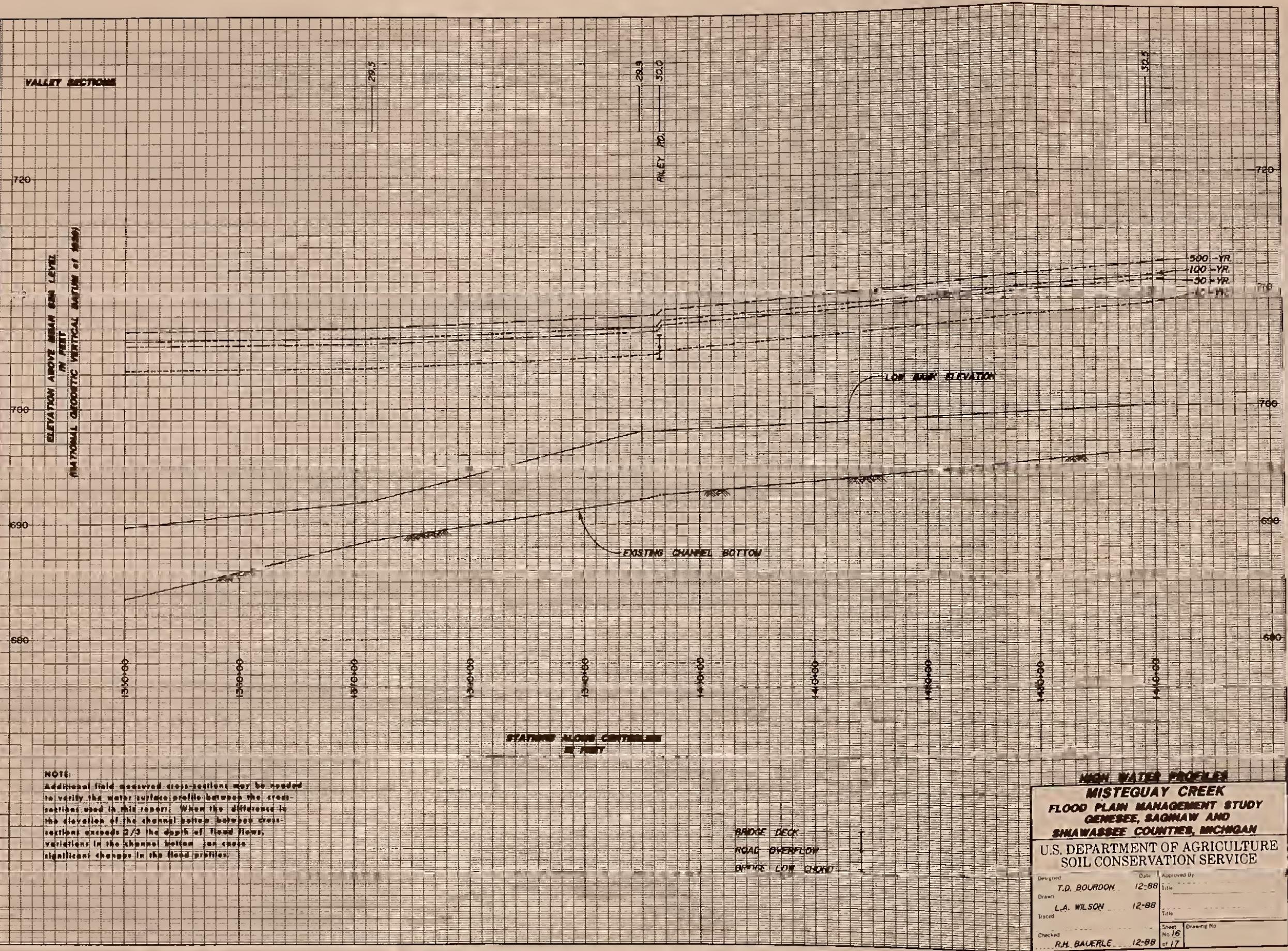
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA

MISTEGUAY CREEK

VALLEY SECTION

NATIONAL AERONAUTIC UNION OF 1933
ELEVATION ABOVE MEAN SEA LEVEL
IN FEET



**LEGEND**

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Valley Section Location

Stream Channel

Temporary Bench Mark

TBM 9.1

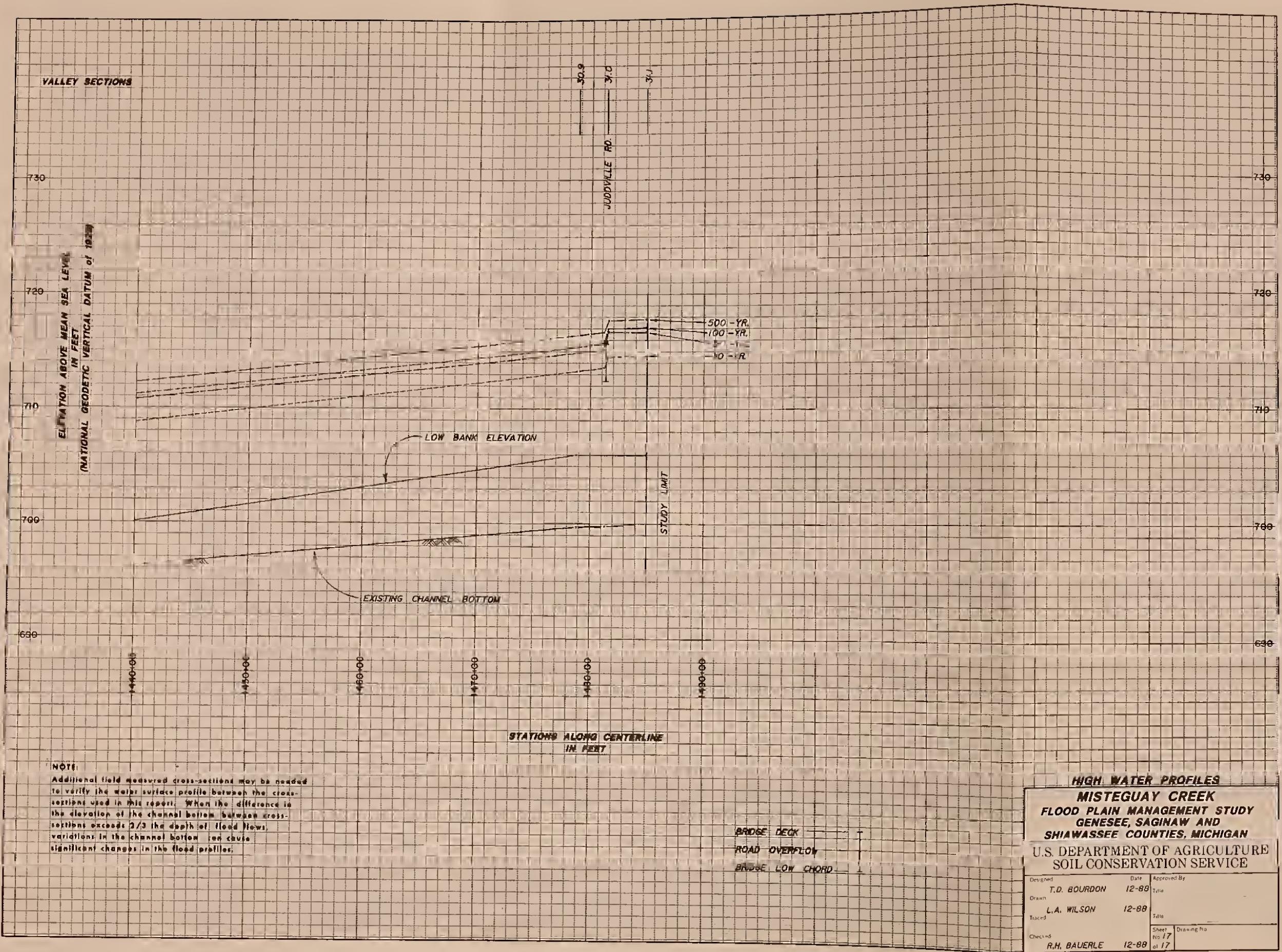
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ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
THE PHOTOGRAPHIC IMAGE MAY VARY FROM TRUE
GROUND LOCATION.

SCALE 0 800 1600 FEET
0 200 400 METERS
APPROXIMATE

January 3, 1988 Photography From
Abrams Aerial Survey Corp.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND SHIAWASSEE COUNTIES,
MICHIGAN

FLOOD HAZARD AREA**MISTEGUAY CREEK**



HIGH WATER PROFILES		
MISTEGUAY CREEK		
FLOOD PLAIN MANAGEMENT STUDY		
GENESEE, SAGINAW AND		
SHIAWASSEE COUNTIES, MICHIGAN		
U.S. DEPARTMENT OF AGRICULTURE		
SOIL CONSERVATION SERVICE		
Designed T.D. BOURDON	Date 12-88	Approved By Title
Drawn L.A. WILSON	12-88	
Traced R.H. BAUERLE	12-88	Title Drawing No No 17 of 17
Checked R.H. BAUERLE	12-88	



LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- 8.0 Valley Section Location

Stream Channel

Temporary Bench Mark

NOTE

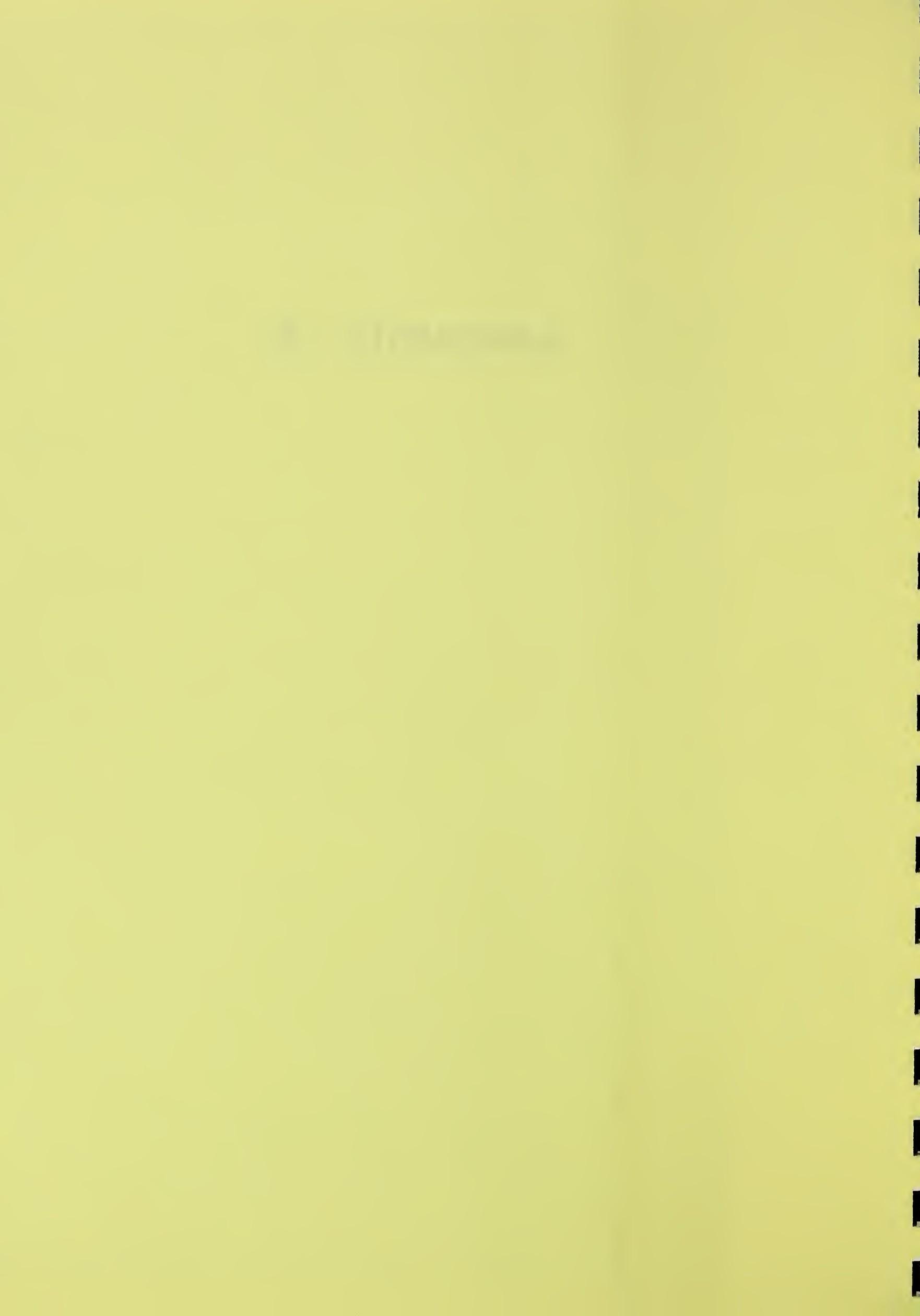
LIMITS OF FLOODING SHOWN MAY VARY FROM
ACTUAL LOCATIONS ON THE GROUND AND DUE TO
INHERENT AERIAL PHOTOGRAPHIC DISPLACEMENT
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GROUND LOCATION.

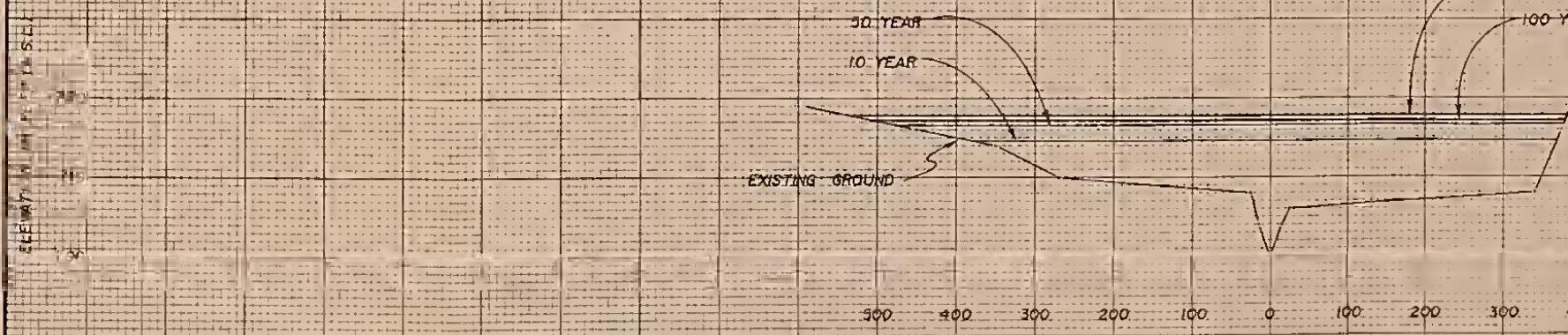
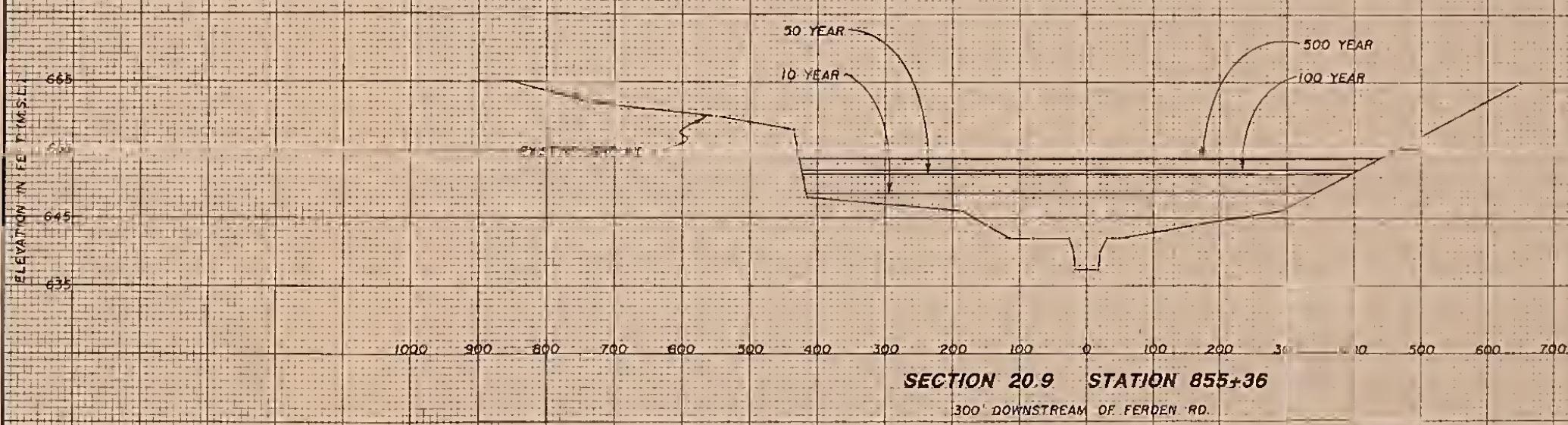
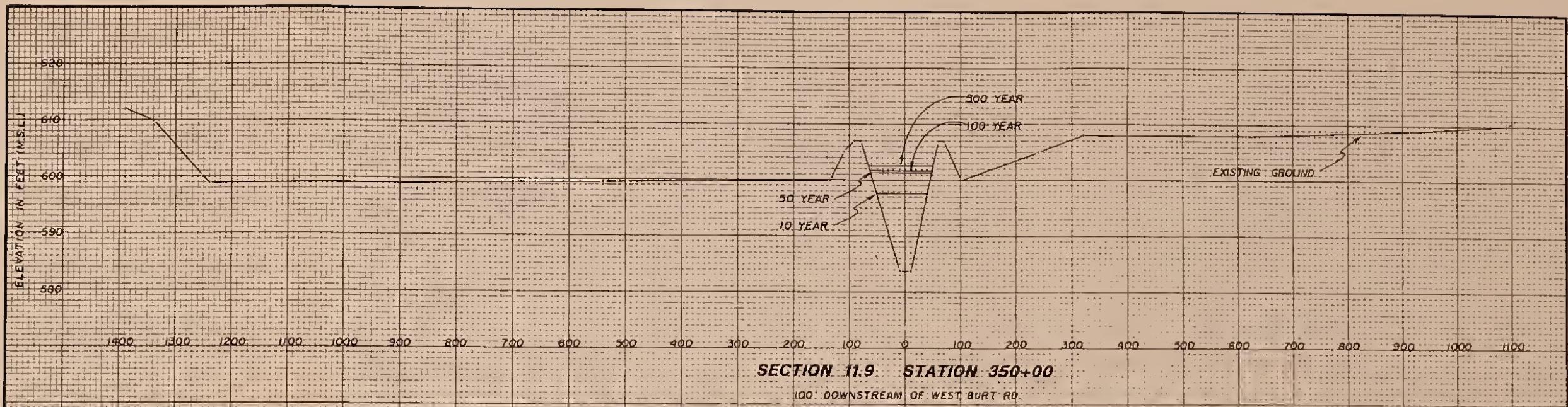
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0 200 400 METERS
APPROXIMATE

January 3, 1988 Photography From
Abrams Aerial Survey Corp.

R 4 E

APPENDIX B





TYPICAL VALLEY SECTIONS

MISTEGUAY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GENESEE, SAGINAW AND
SHIAWASSEE COUNTIES, MICHIGAN
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Design:	T.D. BOURDON	Date:	2-89
Draw:	L.A. WILSON	Date:	2-89
Transl:	R.H. BAUERLE	Date:	2-89
Checkd:		Sheet:	1

APPENDIX C

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
Confluence of Flint River <u>1/</u>	7.1	0+00	589.7	592.7	593.8	596.6
	7.5	58+00	589.7	592.7	593.8	596.6
Fry Rd.	8.00 D <u>2/</u>	122+56	589.9	592.8	593.9	596.6
	8.00 U <u>2/</u>	122+86	590.0	592.9	593.9	596.7
	8.5	178+20	590.1	592.9	594.0	596.7
	8.9	228+00	590.5	593.0	594.1	596.8
Verne Rd.	9.00 D	230+90	590.5	593.1	594.1	596.8
	9.00 U	231+10	591.3	593.2	594.2	596.8
	9.9	260+71	591.8	593.7	594.5	596.9
Fergus Rd.	10.00 D	261+53	591.9	593.7	594.5	596.9
	10.00 U	261+89	591.9	593.7	594.5	596.9
	10.9	284+79	592.6	595.5	596.5	598.3
Birch Run Rd.	11.00 D	285+69	592.6	595.6	596.5	598.3
	11.00 U	285+89	592.6	596.6	596.8	598.4
	11.5	324+00	595.4	599.2	599.6	600.6
	11.9	350+00	597.7	601.3	601.7	602.7
West Burt Rd.	12.00 D	350+84	597.8	601.4	601.8	602.8
	12.00 U	351+16	598.4	601.6	601.9	604.6
	12.5	377+50	598.8	602.5	603.0	605.5
	12.9	402+00	599.5	603.5	604.2	606.5
West Gary Rd.	13.00 D	408+54	599.5	603.5	604.2	606.5
	13.00 U	408+70	599.8	604.0	604.9	607.6
	13.5	409+90	599.8	604.2	605.0	607.7
Lincoln Rd.	14.00 D	410+96	599.8	604.2	605.0	607.7
	14.00 U	411+40	599.8	604.2	605.0	609.0
	14.9	428+18	603.2	607.5	608.3	610.6
	14.95	449+15	606.6	610.8	611.4	613.3

1/ Starting Elevations from 1978 Spaulding Township Flood Insurance Study.

2/ "D" and "U" represent downstream and upstream face of bridge.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
Above Structure 4	15.0	450+15	628.4	630.2	630.5	631.6
	15.9	473+53	628.4	630.2	630.5	631.6
Bueche Rd. <u>1/</u>	16.0	486+53	628.4	630.2	630.5	631.6
	16.5	525+88	628.4	630.3	630.6	631.7
	16.9	564+22	628.4	630.3	630.6	631.7
Chesaning Rd.	17.00 D	565+07	628.4	630.3	630.6	631.8
	17.00 U	565+37	628.5	630.6	631.0	632.3
	17.5	575+22	628.6	630.7	631.0	632.3
	17.9	590+43	628.6	630.7	631.1	632.4
	17.95	594+43	628.6	630.7	631.1	632.5
East Rd.	18.00 D	597+02	628.6	630.7	631.1	632.5
	18.00 U	597+34	628.7	631.2	631.7	633.1
	18.5	631+90	629.0	631.6	632.2	633.7
	18.9	651+40	630.1	633.1	633.7	635.4
Volkmer Rd.	19.00 D	653+33	630.2	633.2	633.9	635.6
	19.00 U	653+47	630.3	633.8	634.3	636.0
	19.5	704+00	635.9	638.7	639.3	640.9
	19.9	731+38	638.4	641.0	641.7	643.2
M-57	20.00 D	749+68	642.1	644.4	644.9	646.3
	20.00 U	750+08	642.3	645.4	646.2	648.2
	20.5	814+75	646.5	649.2	649.9	651.5
	20.9	855+36	648.6	651.3	652.0	653.7
Ferden Rd.	21.00 D	858+23	648.7	651.5	652.2	653.8
	21.00 U	858+49	650.7	652.8	653.3	654.7
	21.1	859+36	650.8	652.8	653.4	654.7
	21.95	866+46	650.9	653.0	653.5	654.9

1/ Treated as Valley Section.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
Above Structure 3A	22.0	869+46	661.3	663.0	663.4	664.2
	22.5	897+50	661.6	663.4	663.8	664.9
	22.9	938+30	661.8	663.7	664.2	665.3
Ditch Road	23.00 D	941+66	661.8	663.7	664.2	665.4
	23.00 U	941+94	662.1	664.2	664.7	666.3
	23.5	974+80	662.3	664.5	665.1	666.7
	23.9	1032+16	663.8	665.9	666.5	668.2
Byron Rd. 1/	24.0	1033+16	663.8	665.9	666.5	668.2
	24.5	1069+93	666.7	669.2	669.9	671.5
	24.7	1118+99	670.6	672.7	673.3	674.7
	24.9	1151+85	672.5	674.8	675.5	677.1
Easton Rd.	25.00 D	1152+67	672.6	674.9	675.6	677.2
	25.00 U	1153+03	673.5	676.3	677.4	679.0
	25.1	1154+35	673.5	676.3	677.4	679.1
Above Conflu- ence of Porter Cr.	25.2	1171+85	674.8	677.8	678.7	680.4
Above Conflu- ence of Onion Cr.	25.5	1187+54	675.6	678.8	679.7	681.3
	25.9	1222+47	680.3	683.5	684.0	685.3
Allan Rd.	26.00 D	1226+12	680.9	684.0	684.5	685.8
	26.00 U	1226+32	681.8	685.5	686.0	687.0
	26.9	1274+58	685.8	689.0	689.5	690.8
	26.95	1277+58	686.3	689.4	689.9	691.2

1/ Byron Road treated as Valley Section.

TABLE 4 - FLOOD ELEVATIONS AT SECTIONS

Location	Section	Station	10-Year	50-Year	100-Year	500-Year
Above Structure 2	27.0 27.9	1278+58 1318+83	702.8 702.8	704.8 704.9	705.2 705.2	705.9 706.0
Henderson Road	28.00 D 28.00 U 28.5	1319+64 1320+02 1334+68	702.8 702.9 703.0	704.9 705.0 705.0	705.2 705.4 705.4	706.0 706.2 706.2
New Lothrop Rd.	29.00 D 29.00 U 29.5 29.9	1336+40 1336+56 1371+53 1394+82	703.0 703.1 703.5 704.6	705.0 705.2 705.6 706.6	705.4 705.6 706.1 707.0	706.2 706.4 707.0 708.0
Riley Rd.	30.00 D 30.00 U 30.5 30.9	1396+35 1396+69 1439+55 1478+85	704.7 705.0 708.7 713.3	706.7 707.2 710.7 714.9	707.1 707.6 711.1 715.4	708.1 708.5 712.2 716.4
Juddville Rd.	31.00 D 31.00 U 31.1	1481+15 1481+55 1484+85	713.6 714.5 714.6	715.2 716.7 716.7	715.7 717.0 717.1	716.7 717.7 717.8

APPENDIX D



INVESTIGATIONS AND ANALYSIS

Survey Procedures

Field surveys were made of bridges, roads, structures, channels and flood plains of Misteguay Creek and its tributaries by the Soil Conservation Service in December 1987 and completed in February 1988. Temporary bench marks based on USC and GS mean sea level elevation datum of 1929 were established using second order accuracy. Temporary bench marks are described in Appendix E.

For the Misteguay Creek and its tributaries, 24 roads, bridges and structures were surveyed. Aerial photography flown on January 3, 1988 was used as a base for the photo mosaic sheets used to delineate the flood plains. U.S. Geologic Survey topographic maps, 1-foot contour maps prepared by the U.S. Corps of Engineers in 1983 and 2-foot contour maps prepared by the Soil Conservation Service in the late 1950's and early 1960's were used to develop 38 valley cross-sections. The 2-foot contour maps prepared by the Soil Conservation Service were checked for accuracy by comparing recently surveyed road cross-sections with cross-sections scaled from the 2-foot contour maps.

Hydrology and Hydraulics

Physical data were obtained from U.S.G.S. topographic maps, soil survey maps, local topographic maps and aerial photographs, as well as on-site field inspections. The watershed boundary was determined from map studies and field checks. The watershed was divided into 15 sub-watershed areas for use in evaluating the runoff volumes. Drainage areas for the sub-watersheds were measured from U.S.G.S. topographic maps using Geographic Information Systems. Times of concentration were calculated for the sub-watersheds using the Michigan DNR UD-21 method and Manning's formula. Each sub-watershed was evaluated for land use, cover and soils. Runoff curve numbers were calculated using Geographic Information Systems as described in Part 7 of the Technical Report.

Channel flood routings to establish peak discharge-frequency relationships were made using the PC version of the SCS TR-20 Hydrology Computer Program dated September 1, 1983. The Modified Attenuation-Kinematic (Att-Kin) method of routing through stream channels is used by this program. This method is derived from inflow-outflow hydrograph relationships. Elevation-storage-discharge relationships for the three dams were obtained from the March 1986 Report on the Misteguay Watershed by Baxter E. Vieux, P.E. The TR-20 computer program uses these data and the Storage-Indication Method of evaluating the effect of the structures in reducing peak flood discharges. Table 3, Appendix C lists discharges obtained from the flood routings and Table 4, Appendix C lists flood elevations at sections located in the study area. In accordance with criteria as set forth in SCS TR-60, Earth Dams and Reservoirs (Rev. 8/1985), 4 cfs/square mile (csm) was added to account for snow melt in the 50-, 100- and 500-year floods and 2 (csm) was added for the 2- and 10-year floods.

The TR-20 model was calibrated to reproduce the September 5-6, 1985 flood event and has been accepted as a basis of the hydrology and flood routing for the main stem of the Mistequay Creek by the Michigan Department of Natural Resources.

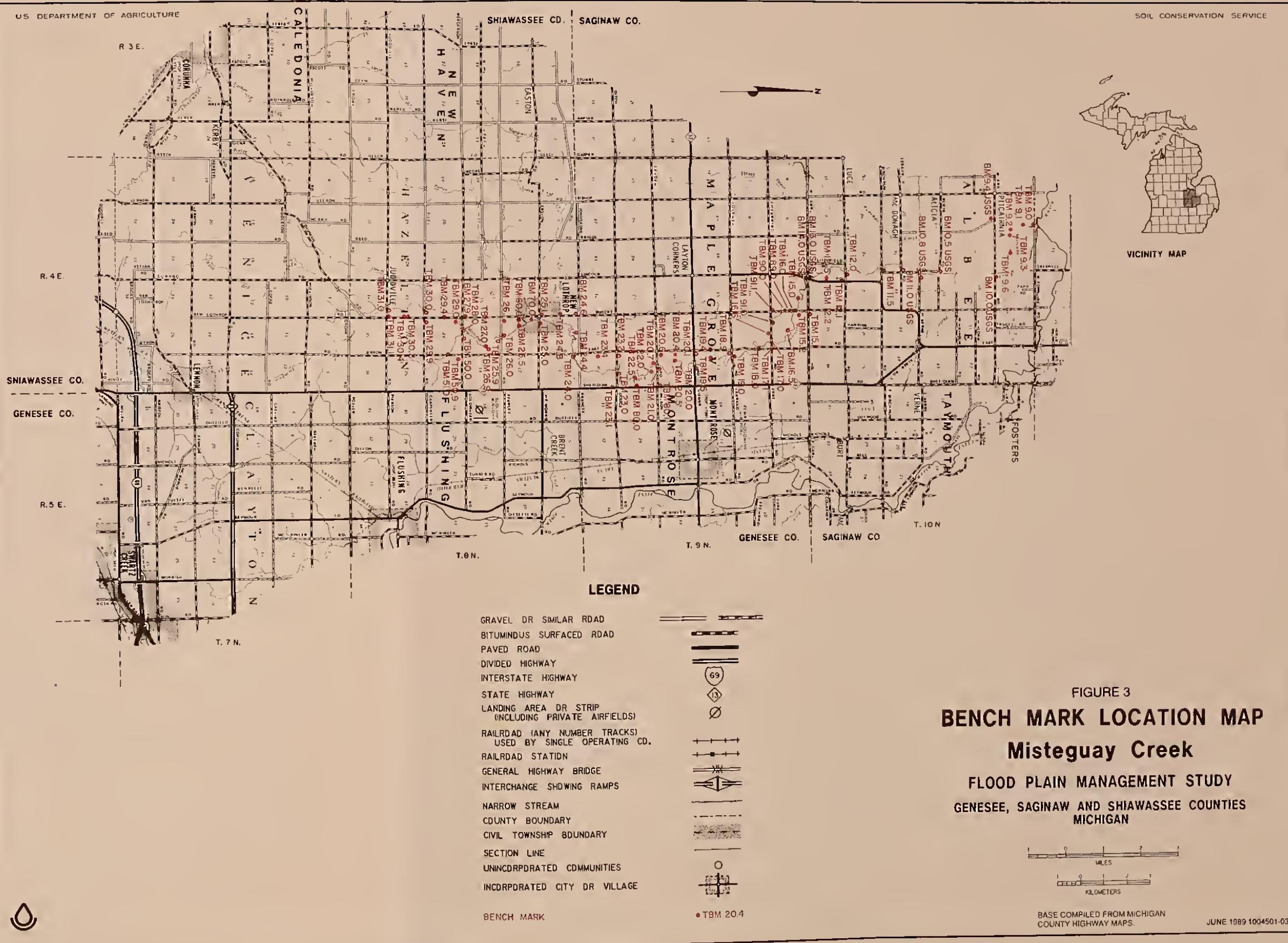
Water surface profiles for Misteguay Creek were developed using the Soil Conservation Service WSP-2 computer program. This program uses the step method of computation to solve the Bernoulli equation, and the Bureau of Public Roads bridge loss analysis. Flood discharges determined from flood routings were used in the water surface profile program to develop high water profiles along the channel. Manning's "n" values were determined from field investigations of the channel and flood plain. Starting elevations at the Flint River were obtained from the Flood Hazard Maps of Spalding Township prepared by the U.S. Corps of Engineers in 1978. Also, it is assumed that the dikes along the channel at the lower end of the study area will breach during flood flows.

Normal bridge and channel flow conditions were assumed in the hydraulic computations. No consideration was made for openings blocked by ice or other debris. Channel and flood plain flow characteristics may change due to vegetative growth, sedimentation, scour, debris accumulation, filling and encroachment. Computations for this study considered only those features in the flood plain at the time of the field surveys. Future flood plain developments and modifications, as well as changes in the upstream drainage areas and land use and cover, will require recomputation of water surface profiles.

Flood plain delineations were made on the contour maps and photo map sheets. Computed water surface elevations at surveyed sections and bridges were used to identify flood plain limits. Between sections, topographic map interpretations and field inspections were used to delineate the flood boundary lines. Limits of flooding shown on the photo maps may vary from true ground location due to inherent aerial photographic displacement. High water profile elevations and detailed field surveys should be used to determine the extent or depth of flooding at any specific site.

Where the limits of the 500-year and 100-year floods were too close to delineate, the limits of the two flood plains are shown as the same line on the photo maps sheets.

APPENDIX E



BENCH MARK DESCRIPTIONS *

MISTEGUAY CREEK

SAGINAW COUNTY, MICHIGAN

TBM 9.0

Section 32, Spaulding Township, T11N, R4E - Located on top of west dike, approximately 200 feet upstream of confluence of Misteguay Creek and Flint River on west bank of Misteguay Creek.

SCS spike and disk in southeast base of 3-foot diameter cottonwood tree.

Elev. 593.14

TBM 9.1

Section 5, Albee Township, T10N, R4E - Located at west toe of west dike of Misteguay Creek, approximately 2,050 feet upstream of confluence of Misteguay Creek and Flint River.

SCS spike and disk in east side of 3-foot diameter lone wolf cottonwood tree.

Elev. 591.00

TBM 9.2

Section 5, Albee Township, T10N, R4E - Located at top of south dike of Misteguay Creek, approximately 2,550 feet northeast of Fry Road-Horningcut Road intersection. Also, approximately 4,300 feet upstream of confluence of Misteguay Creek and Flint River, where creek turns from west to north flow direction.

SCS spike and disk in west side of 3-foot diameter stump.

Elev. 594.76

TBM 9.3

Section 4, Albee Township, T10N, R4E - Located at south toe of south dike of Misteguay Creek, approximately 5,000 feet upstream of confluence of Misteguay Creek and Flint River, and approximately 700 feet upstream of TBM 9.2

SCS spike and disk in north side of dead lone wolf tree.

Elev. 585.51

* Elevations based on USC&GS mean sea level datum of 1929.

BM 9.4 USGS

ST. CHARLES QUAD.-102; LINE 7, 2-68-5.1 1/.

BM 10 DFP 1974, St. Charles, 0.5 mi S. and 6.25 mi E. of; 3 mi S. and 5.25 mi W. of Orville.

Located in the NE cor. of sec. 8, T10N, R4E, 26 ft S. and 76 ft W. of T-rd. S. (Fry and Horningcut Roads), 5 ft W. of drain bank, 1 ft S. of USGS witness post, set in 6-in. field tile, set flush with ground, a standard tablet stamped "10 DFP 1974".

Elev. 586.114

TBM 9.6

Section 4, Albee Township, T10N, R4E - Located on south toe of south dike of Misteguay Creek, approximately 3,000 feet upstream of TBM 9.2.

SCS spike and disk in north side of north bole (trunk) of 5 boled red maple tree.

Elev. 590.76

BM 10.0 USGS

ST. CHARLES/SAGINAW QUAD.-106; LINE 7, 2-70-6.3 1/.

UE 10 A, 1.25 mi E. of tablet near, the cor. of secs. 3, 4, 9 and 10, T10N, R4E, 17 ft N. and 77 ft E. of centerline of bridge, on NW. cor. of top step of E. concrete abutment, a chiseled square (Fry Road bridge over Misteguay Creek).

Elev. 601.01

BM 10.5 USGS 2/

ST. CHARLES/SAGINAW QUAD.-106; LINE 7, 2-60-1.9 1/.

UE 21 CC, 1 mi N. and 0.2 mi E. of tablet, near the quarter cor. between secs. 15 and 16, T10N, R4E, 39 ft N. of (Alicia) Road tangent W., 9 ft W. of centerline of gate at road N., 0.3 ft W. of W. iron gate post in concrete base, a chiseled square.

Elev. 598.38

- 1/ USDI, GEOLOGICAL SURVEY quadrangle name and number, survey line number and line I.D. numbers for each bench mark.
- 2/ Note: Preliminary adjustment; pending additional leveling by USDI, Geological Survey.

BM 10.8 USGS 2/

ST. CHARLES/SAGINAW QUAD.-106; LINE 7, 2-58-1.9 1/.

UE 21 BB, 0.5 mi N. and 0.2 mi E. of tablet, near the cor. of secs. 15, 16, 21 and 22; T10N, R4E, 8 ft N. and 40 ft E. of centerline (Vernie Road) bridge over Misteguay Creek, 72 ft W. and 8 ft N. of T-rd. S., on E. end of N. curb of bridge, a chiseled square.

Elev. 598.32

BM 11.0 USGS

ST. CHARLES/SAGINAW QUAD.-106; LINE 3, 14.3 1/.

St. Charles, 3.0 mi S. and 6.75 mi E. of; T10N, R4E, in the SE. quarter of section 21, at a concrete bridge on Fergus Road over the Misteguay Creek; 16 ft N. and 3.4 ft W. of E. end of bridge and 0.7 ft higher than; on the NE. cor. of the N. curbing of bridge; a standard tablet stamped "21 PR 1966" and set in concrete curb.

Elev. 603.459

TBM 11.5

Section 21, Albee Township, T10N, R4E - Located on Birch Run Road bridge over Misteguay Creek.

Chiseled square at end of northeast concrete wingwall.

Elev. 599.60

TBM 12.0

Section 28, Albee Township, T10N, R4E - Located on West Burt Road bridge over Misteguay Creek in southeast corner of section.

Chiseled square in northeast corner of top step of northeast abutment.

Elev. 605.34

TBM 12.1

Section 34, Albee Township, T10N, R4E - Located at southwest corner of West Burt Road and Lincoln Road intersection.

SCS spike and disk in southwest side of utility pole.

Elev. 611.77

- 1/ USDI, GEOLOGICAL SURVEY quadrangle name and number, survey line number and line I.D. numbers for each bench mark.
- 2/ Note: Preliminary adjustment; pending additional leveling by USDI, Geological Survey.

TBM 12.2

Section 34, Albee Township, T10N, R4E - Located 280 feet west of Lincoln Road on east-west quarter line.

SCS spike and disk in north side utility pole.

Elev. 619.35

TBM 12.5

Section 34, Albee Township, T10N, R4E - Located on top of bluff above Misteguay Creek, 25 feet southwest of southwest corner of crop field, approximately 1,250 feet west of Lincoln Road on east-west quarter line of section.

SCS spike and disk in south side 18-inch diameter white oak tree.

Elev. 612.75

BM 13.0 USGS

BURT QUAD.-90; LINE 7, 2-42-7.3 1/.

Section 34, Albee Township, T10N, R4E. Reference mark, NW. of tablet on E.-W. road, 16 ft N. and 196 ft W. of crossroads (Lincoln & Gary) on NE. end of NE. concrete wingwall of steel truss bridge, a chiseled square.

Elev. 609.45

BM 14.0 USGS

BURT QUAD.-90; LINE 7, 2-40-7.2 1/.

Section 3, Maple Grove Township, T9N, R4E. BM, New Lothrop, 7 mi N. and 1 mi W. of, 61 ft NE. along road and 20 ft W. at right angle to road from centerline of (Lincoln Road) bridge over Misteguay Creek, at NW. cor. of bridge on top of parapet, a standard tablet set flush in a drill hole stamped "9 DFP 1974".

Elev. 613.860

TBM 15.0

Section 3, Maple Grove Township, T9N, R4E - Located on Str. #4 Dam on Misteguay Creek, approximately 1,200 feet south of Gary Road.

USDA brass plate located in north wingwall (right side looking downstream) near junction of headwall and wingwall of outlet end of dam.

Elev. 607.55

1/ USDI, GEOLOGICAL SURVEY quadrangle name and number, survey line number and line I.D. numbers for each bench mark.

TBM 15.1

Section 35, Albee Township, T10N, R4E - Located at northeast corner of intersection of Bueche Road and Gary Road, in the southwest corner of the section.

SCS spike and disk in south side of utility pole.

Elev. 635.03

TBM 15.2

Section 2, Maple Grove Township, T9N, R4E - Located on east side of Bueche Road, approximately 750 feet south of Gary Road, across from driveway for address 14110, near west section line.

SCS spike and disk in southwest side of tree.

Elev. 633.56

TBM 16.0

Section 3, Maple Grove Township, T9N, R4E - Located at Misteguay Creek and Bueche Road, near east section line.

Top of west most steel peg protruding from west corner of south bridge abutment (bridge no longer exists).

Elev. 612.85

TBM 16.5

Section 2, Maple Grove Township, T9N, R4E - Located at northeast corner of crop field, 240 feet back from top of bluff over Misteguay Creek, on north-south quarter line, approximately 2,700 feet north of Chesaning Road.

SCS spike and disk in east base of 10-inch diameter elm tree.

Elev. 629.55

TBM 16.6

Section 11, Maple Grove Township, T9N, R4E - Located on south side of Chesaning Road near 1/4 section line near the north section line.

SCS spike and disk in west side of utility pole.

Elev. 642.31

TBM 17.0

Section 2, Maple Grove Township, T9N, R4E - Located on Chesaning Road bridge over Misteguay Creek.

Chiseled square on top west side of northeast bridge abutment.

Elev. 632.72

TBM 17.1

Section 2, Maple Grove Township, T9N, R4E - Located at northwest corner of intersection of Chesaning Road and East Road.

SCS spike and disk in northwest side of utility pole.

Elev. 642.48

TBM 18.0

Section 11, Maple Grove Township, T9N, R4E - Located on East Road bridge over Misteguay Creek.

Chiseled square on northwest corner of northwest concrete abutment.

Elev. 636.41

TBM 18.9

Section 13, Maple Grove Township, T9N, R4E - Located at southeast corner of intersection of East Road and Volkmer Road.

SCS spike and disk in east base utility pole.

Elev. 649.46

TBM 19.0

Section 12, Maple Grove Township, T9N, R4E - Located on Volkmer Road bridge over Misteguay Creek.

Top of west most iron rail post supporting northwest abutment.

Elev. 637.22

TBM 19.4

Section 14, Maple Grove Township, T9N, R4E - Located on west side of East Road on south side of driveway, at east-west quarter line.

SCS spike and disk in east side utility pole.

Elev. 651.04

TBM 19.5

Section 13, Maple Grove Township, T9N, R4E - Located on top of west bluff above Misteguay Creek, approximately 1,400 feet east of East Road and approximately 15 feet north of fence post marking east-west quarter line.

SCS spike and disk in south side of 6-inch diameter elm tree.

Elev. 638.48

TBM 20.0

Section 13, Maple Grove Township, T9N, R4E - Located on Peet Road (M-57) bridge over Misteguay Creek.

Chiseled square on northeast corner of top step of northeast bridge abutment.

Elev. 652.37

TBM 20.1

Section 13, Maple Grove Township, T9N, R4E - Located in northeast corner of intersection of East Road and Peet Road (M-57), approximately 200 feet east of intersection.

SCS spike and disk in northeast side of utility pole.

Elev. 655.72

TBM 20.4

Section 24, Maple Grove Township, T9N, R4E - Located on east side of East Road, near 1/4 section line on west section line.

SCS spike and disk in east side of south gate post.

Elev. 660.36

TBM 20.5

Section 24, Maple Grove Township, T9N, R4E - Located on south side of field driveway, on north side of gully, on west bank of Misteguay Creek, approximately 1,300 feet east of East Road, in SW corner of SE 1/4 of NW 1/4.

SCS spike and disk in northeast side of 16-inch diameter tree.

Elev. 645.47

TBM 20.6

Section 24, Maple Grove Township, T9N, R4E - Located under farm lane ditch crossing, on east side of East Road, approximately 700 feet north of Ferden Road.

Top of south end of concrete culvert.

Elev. 662.53

TBM 20.7

Section 25, Maple Grove Township, T9N, R4E - Located under driveway ditch crossing to metal sided garage, south side of Ferden Road, approximately 800 feet west of bridge over Misteguay Creek.

Top of west end of concrete culvert.

Elev. 663.08

TBM 21.0

Section 24, Maple Grove Township, T9N, R4E - Located on Ferden Road bridge over Misteguay Creek.

Northeast corner of lower step of northeast abutment.

Elev. 650.32

TBM 22.0

Section 25, Maple Grove Township, T9N, R4E - Located on Structure #3A Dam on Misteguay Creek just south of Ferden Road.

USDA bronze plate set in north end (right side looking downstream) of headwall of outlet end of dam.

Elev. 650.46

TBM 22.5

Section 25, Maple Grove Township, T9N, R4E - Located on east side of Misteguay Creek on top of bluff above creek, adjacent to off road vehicle trail, approximately 680 feet south of confluence of Misteguay Creek and Reed Drain, approximately 1,600 feet west of M-13 (Sheridan Road).

SCS spike and disk in east base of 2-foot diameter red oak tree.

Elev. 667.52

TBM 23.0

Section 25, Maple Grove Township, T9N, R4E - Located on Ditch Road bridge over Misteguay Creek.

Chiseled square on northeast abutment.

Elev. 664.41

TBM 23.1

Section 36, Maple Grove Township, T9N, R4E - Located in southwest corner of intersection of Ditch Road and Sheridan Road (M-13).

SCS spike and disk in northwest side of utility pole.

Elev. 677.60

TBM 23.2

Section 25, Maple Grove Township, T9N, R4E - Located at northeast corner of intersection of Ditch Road and East Road.

SCS spike and disk in south base of utility pole.

Elev. 675.36

TBM 23.4

Section 36, Maple Grove Township, T9N, R4E - Located under ditch crossing on east-west quarter line, on east side of East Road.

Punch mark in north end of corrugated metal pipe culvert.

Elev. 676.23

TBM 80.0

Section 25, Maple Grove Township, T9N, R4E - Located on M-13 bridge over Reed Drain.

Chiseled square on north end of west (downstream) headwall.

Elev. 662.40

TBM 80.1

Section 24, Maple Grove Township, T9N, R4E - Located at northwest corner of intersection of Ferden Road and M-13.

SCS spike and disk in south base of utility pole.

Elev. 673.43

TBM 89.0

Section 3, Maple Grove Township, T9N, R4E - Located on driveway bridge over Northwood Creek on west side of Bueche Road, approximately 100 feet south of barrier where Bueche Road ends south of Misteguay Creek, near east section line.

Chiseled square in northeast bridge abutment.

Elev. 611.22

TBM 90.0

Section 3, Maple Grove Township, T9N, R4E - Located on Bueche Road bridge over Northwood Creek, approximately 1/4 mile north of Chesaning Road, near east section line.

Top of rock (painted orange) protruding from northwest corner of northwest field-stone bridge abutment.

Elev. 611.84

TBM 91.0

Section 2, Maple Grove Township, T9N, R4E - Located on northeast side of Chesaning Road bridge over Northwood Creek.

SCS spike and disk in east side of guardrail post.

Elev. 630.21

TBM 91.1

Section 3, Maple Grove Township, T9N, R4E - Located at northwest corner of intersection of Bueche Road and Chesaning Road.

SCS spike and disk in north base of utility pole.

Elev. 640.57

SHIAWASSEE COUNTY, MICHIGAN

TBM 24.0

Section 1, Hazelton Township, T8N, R4E - Located at mid-channel of Misteguay Creek, of dilapidated Byron Road bridge.

Chiseled square in east end of concrete bridge pier.

Elev. 664.15

TBM 24.4

Section 2, Hazelton Township, T8N, R4E - Located on driveway ditch crossing for house address 10260, south side of Johnstone Road.

Chiseled square on north end of east headwall.

Elev. 681.06

TBM 24.6

Section 3, Hazelton Township, T8N, R4E - Located on southwest corner of intersection of New Lothrop Road and Johnstone Road.

Chiseled square on south end of 24-inch I.D. concrete road culvert.

Elev. 682.90

TBM 24.8

Section 3, Hazelton Township, T8N, R4E - Located on west side of New Lothrop Road adjacent to ditch on north Emmendorfer property line, on east-west quarter line.

SCS spike and disk in east base of utility/light pole.

Elev. 688.96

TBM 25.0

Section 2, Hazelton Township, T8N, R4E - Located on Easton Road bridge over Misteguay Creek.

Chiseled square on northeast corner of top step of northeast abutment.

Elev. 677.37

TBM 25.1

Section 3, Hazelton Township, T8N, R4E - Located in New Lothrop at the northwest corner of New Lothrop Road and Easton Road intersection near fire hydrant.

SCS spike and disk in east base of utility pole.

Elev. 694.67

TBM 25.5

Section 11, Hazelton Township, T8N, R4E - Located east of east-west fence line corner, approximately 1,300 feet east of New Lothrop Road near east-west quarter line.

SCS spike and disk in north side of 10-inch diameter tree (painted ring around tree).

Elev. 676.03

TBM 25.9

Section 14, Hazelton Township, T8N, R4E - Located at south end of east abutment of Allan Road bridge over Misteguay Creek.

Southwest corner of steel plate.

Elev. 684.78

TBM 26.0

Section 11, Hazelton Township, T8N, R4E - Located 30 feet north and 110 feet west of west end of Allan Road bridge over Misteguay Creek.

Spike located in southeast base utility pole.

Elev. 681.09

TBM 26.1

Section 11, Hazelton Township, T8N, R4E - Located under Allan Road on east side of New Lothrop Road (northeast corner of intersection).

Punch mark on north end of 24-inch diameter corrugated metal pipe culvert.

Elev. 703.14

TBM 26.9

Section 14, Hazelton Township, T8N, R4E - Located adjacent to west gate post at gateway access to Misteguay Creek dam located south of Allan Road.

Railroad spike located in east side of utility pole.

Elev. 708.58

TBM 27.0

Section 14, Hazelton Township, T8N, R4E - Located on Misteguay Creek dam structure #2 south of Allan Road, approximately 200 feet north of 1/4 section line.

USDA brass plate in east end (right side looking downstream) of downstream headwall.

Elev. 691.04

TBM 27.9

Section 15, Hazelton Township, T8N, R4E - Located at northwest corner of intersection of Henderson Road and New Lothrop Road.

Spike in east base of utility pole.

Elev. 714.01

TBM 28.0

Section 14, Hazelton Township, T8N, R4E - Located on Henderson Road bridge over Misteguay Creek.

Chiseled square on northeast wingwall.

Elev. 691.70

TBM 29.0

Section 23, Hazelton Township, T8N, R4E - Located on New Lothrop Road bridge over Misteguay Creek.

Chiseled square in southeast abutment.

Elev. 693.29

TBM 29.4

Section 22, Hazelton Township, T8N, R4E - Located under field access ditch crossing located approximately 135 feet south of driveway for address 5257 on west side New Lothrop Road, near east-west quarter line.

Chiseled square on north end 15-inch I.D. concrete culvert.

Elev. 714.84

TBM 29.9

Section 23, Hazelton Township, T8N, R4E - Located at northeast corner of intersection of Riley Road and New Lothrop Road.

SCS spike and disk in west base of utility pole.

Elev. 719.11

TBM 30.0

Section 22, Hazelton Township, T8N, R4E - Located on Riley Road bridge over Misteguay Creek.

Chiseled square on top step of northeast concrete abutment.

Elev. 707.30

TBM 30.3

Section 27, Hazelton Township, T8N, R4E - Located on west side of New Lothrop Road, approximately 400 feet (2nd pole) north of driveway for address 4501 and TBM 30.4.

SCS spike and disk in east side of utility pole.

Elev. 724.30

TBM 30.4

Section 27, Hazelton Township, T8N, R4E - Located on west side of New Lothrop Road on north side of driveway for address 4501 near east-west quarter line.

SCS spike and disk in east side of utility pole.

Elev. 724.26

TBM 31.0

Section 27, Hazelton Township, T8N, R4E - Located on Juddville Road bridge over Misteguay Creek.

Chiseled square on west side of lower step of northeast abutment.

Elev. 712.13

TBM 31.1

Section 27, Hazelton Township, T8N, R4E - Located at northwest corner of intersection of New Lothrop Road and Juddville Road.

SCS spike and disk in northeast side of utility pole.

Elev. 726.59

TBM 50.0

Section 14, Hazelton Township, T8N, R4E - Located at Henderson Road crossing over Cronk Drain.

Punch mark in north (downstream) end of 11-inch diameter corrugated metal pipe culvert.

Elev. 696.10

TBM 50.9

Section 24, Hazelton Township, T8N, R4E - Located under Henderson Road on east side of Byron Road (southeast corner of intersection).

Punch mark in south end of 25" x 31" corrugated metal pipe arch.

Elev. 716.80

TBM 51.0

Section 23, Hazelton Township, T8N, R4E - Located under Byron Road at Cronk Drain crossing.

Punch mark in west (downstream) end of 3.5-inch diameter corrugated metal pipe culvert.

Elev. 705.44

TBM 60.0

Section 11, Hazelton Township, T8N, R4E - Located on southeast corner of the top of guardrail on New Lothrop Road bridge over Onion Creek.

Chiseled square on top of concrete guardrail.

Elev. 683.66

TBM 70.0

Section 11, Hazelton Township, T8N, R4E - Located on southeast corner of New Lothrop Road bridge over Porter Creek.

Chiseled square on top of concrete guardrail.

Elev. 682.11

APPENDIX F

GLOSSARY

BACKWATER--The resulting highwater surface upstream from a dam, bridge or other obstruction in a river channel or high stages in a receiving stream.

BRIDGE DECK--Elevation of road surface at the bridge.

BRIDGE LOW CLEARANCE--The lowest point of a bridge or other structure over or across a river, stream or water course that limits the opening through which water flows. This is referred to as "low steel" or "low chord". It often is higher than the low point of the roadway.

CHANNEL or WATER COURSE--An elongated depression either natural or man-made having a bed and well-defined banks varying in depth, width and length which gives direction to a current of water and is normally described as a creek, stream or riverbed.

CHANNEL BOTTOM--The lowest part of the stream channel (either in a constructed cross-section or a natural channel). Bottom elevations at a series of points along the length of a stream may be plotted and connected to provide a stream bottom profile.

CONFLUENCE--A flowing together or place of junction of two or more streams.

CROSS-SECTION or VALLEY SECTION--A graph showing the shape of the stream bed, banks and adjacent land on either side made by plotting elevations at measured distances along a line perpendicular to the flow of the stream.

DATUM--An assumed reference plane from which elevations and depths are measured such as from sea level.

ELEVATION-DISCHARGE RELATIONSHIP--The relationship between water surface elevation and rate of flow at a specified location for a range of flow rates.

FLOOD--A temporary overflow by a river, stream, ocean, lake or other body of land not normally covered by water. It does not include the ponding of surface water due to inadequate drainage such as within a development. It is characterized by damaging inundation, backwater effects of surcharging sewers and local drainage channels, and by unsanitary conditions within adjoining flooded habitated areas attributable to pollutants, debris and water table.

FLOOD CREST--The maximum stage or elevation reached by flood waters at a given location.

FLOOD FREQUENCY--A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. It is customary to estimate the frequency with which specific flood stages or discharges may be equaled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequency", but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years.

10-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 10 years. It has a ten percent chance of being equaled or exceeded in any given year.

100-YEAR FLOOD--A flood having a long-term average frequency of occurrence in the order of once in 100 years. It has a one percent chance of being equaled or exceeded in any given year. This flood is comparable to the "Intermediate Regional Flood" used by the U.S. Army Corps of Engineers.

FLOOD PEAK--The maximum instantaneous discharge or volume of flow in cubic feet per second passing a given location. It usually occurs at or near the time of the flood crest.

FLOOD PLAIN--The relatively flat area or low lands covered by flood waters originating with either the adjoining channel of a water course such as a river or stream, or a body of standing water such as an ocean or lake.

FLOOD PRONE AREA--Areas that experience ponding due to high water table soils and/or inadequate outlets.

FLOOD ROUTING--The process of determining progressively the timing and shape of a flood wave at successive points along a stream. This procedure is used to derive a downstream hydrograph from an upstream hydrograph. Local inflow and tributary hydrographs are considered.

FLOOD STAGE--The elevation at which overflow of the natural stream banks or body of water occurs.

FLOODWAY--The portion of the flood plain including the channel of the stream that is required for the conveyance of flood flow.

FLOODWAY FRINGE--The area of the flood plain lying outside the floodway which may be covered by flood waters originating from an adjoining river or stream.

HEAD LOSS--The effect of obstructions, such as narrow bridge openings, dams or buildings, that limit the area through which water must flow, raising the surface water upstream from the obstruction.

HEADWATER--The tributaries and upper reaches which are the sources of the stream.

HIGH WATER or FLOOD PROFILE--A graph showing the relationship of water surface elevation location along the stream. While it is drawn to show surface elevations for the crest of a specific flood, it may be prepared for conditions at any other given time or stage.

HYDRAULICS--The science of the laws governing the motion of water and their practical applications.

HYDROGRAPH--A graph denoting the discharge or stage of flow over a period of time.

HYDROLOGY--The science dealing with the occurrence and movement of water upon and beneath the land areas of the earth.

INUNDATION--The flooding or overflow of an area with water.

LEFT BANK--The bank of the left side of a river, stream or water course, looking downstream.

LOW GROUND--The highest elevation at a specific stream channel cross-section at which the flow in the stream can be contained in the channel without overflowing into adjacent overbank areas.

MANNING'S "n"--A coefficient of channel and overbank roughness used in Manning's open channel flow formula, commonly called a retardance factor.

REACH LENGTH--A longitudinal length of stream channel selected for use in hydraulic or other computations.

RIGHT BANK--The bank on the right side of the river, stream or water course, looking downstream.

ROAD OVERFLOW--The lowest elevation on a road profile in the vicinity of where the road and stream cross. It is the first point on the roadway inundated if overtopping of the road occurs during a storm.

RUNOFF--That part of precipitation, as well as any other flow contributions, which appears in surface streams of either perennial or intermittent form.

TIME OF CONCENTRATION--Time required for water to flow from the most remote point of a watershed to the outlet or other point of reference.

WATERSHED--A drainage basin or area which collects runoff and transmits it, usually by means of streams and tributaries, to the outlet of the basin.

WATERSHED BOUNDARY--The divide separating one drainage basin from another.

APPENDIX G

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